DOE/ID 10702

Cost Analysis of Alternatives for the Idaho High-Level Waste and Facilities Disposition Environmental Impact Statement

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January 2000

U.S. Department of Energy

Idaho Operations Office

10235/8

Department of Energy

Idaho Operations Office
850 Energy Drive
Idaho Falls, Idaho 83401-1563

January 28, 2000

SUBJECT: Cost Analysis of Alternatives for the Idaho High-Level Waste and Facilities Disposition Environmental Impact Statement (Idaho HLW&FD EIS)

The U.S. Department of Energy (DOE) has prepared a report that compares the costs of alternatives in the Idaho HLW&FD EIS as part of our commitment to the public to make cost information available. Requests for this information were received following public scoping meetings on the Idaho HLW&FD EIS held in 1998.

The Cost Report is provided to present a comparison of the costs for each of the possible/potential options for managing the High-Level Waste and Sodium Bearing Waste/TRU at the Idaho Nuclear Technology and Engineering Center on the Idaho National Engineering and Environmental Laboratory. The Idaho HLW&FD EIS performed detailed analysis of five alternatives for the treatment of waste and the options for each alternative and included five facilities disposition alternatives.

The members of the cost team would like you to read this report remembering that the cost information from this report will be used in several ways:

- As a basis for further cost studies and lifecycle budget formulation;
- To provide relative cost data to be used in the consideration of decisions resulting from the analysis in the Idaho High-Level Waste and Facility Disposition Environmental Impact Statement; and

FOR FURTHER INFORMATION CONTACT: Thomas Wichmann, U.S. Department of Energy, Idaho Operations Office, 850 Energy Place, MS 1108, Idaho Falls, ID 83401, at (208) 526-0535.

Sincerely,

Beverly A. Cook

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Manager

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U.S. Department of Energy

Idaho Operations Office

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ACRONYMS AND ABBREVIATIONS

CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CH	contact-handled
D&D	decontamination and decommissioning
DOE	U.S. Department of Energy
EIS	environmental impact statement
EPA	U.S. Environmental Protection Agency
G&A	general and administrative
HLW	high-level waste
INEEL	Idaho National Engineering and Environmental Laboratory (formerly INEL)
INTEC	Idaho Nuclear Technology and Engineering Center (formerly ICPP)
LLW	low-level waste
LCC	life cycle cost
LMITCO	Lockheed Martin Idaho Technologies Company
MACT	Maximum Achievable Control Technology
NEPA	National Environmental Policy Act
NGLW	newly generated liquid waste
NPV	net present value
NRC	U.S. Nuclear Regulatory Commission
OCRWM	DOE Office of Civilian Radioactive Waste Management
OMB	Office of Management and Budget
OPC	other project cost
RCRA	Resource Conservation and Recovery Act
REP/PC	Range Estimation Program for Personal Computers
RH	remote-handled
ROD	Record of Decision
ROM	range of magnitude [estimates]
SBW	sodium bearing waste
SRS	Savannah River Site
TEC	total estimated cost
TPC	total project cost
TRU	transuranic (waste)
TtNUS	Tetra Tech NUS
TWRS	Tank Waste Remediation System
WIPP	Waste Isolation Pilot Plant
WMPEIS	Waste Management Programmatic EIS

S.1 Introduction

This Cost Analysis of Alternatives (Cost Report) presents and compares the costs of implementing various alternatives for managing high-level waste (HLW) and sodium-bearing liquid waste (SBW) now stored at the Idaho Nuclear Technology and Engineering Center (INTEC) at the Idaho National Engineering and Environmental Laboratory (INEEL). The U.S. Department of Energy (DOE) is currently analyzing the potential environmental impacts of these alternatives in the Idaho High-Level Waste and Facilities Disposition Environmental Impact Statement (Idaho HLW & FD EIS). This EIS will help DOE make decisions about how to treat 4,200 cubic meters of granular solid HLW (calcine) and 1.4 million gallons of SBW (also referred to as mixed transuranic waste) at INTEC and prepare them for permanent disposal. The HLW wastes resulted from reprocessing of government-owned spent nuclear fuel to recover uranium and other materials for reuse. SBW resulted from decontamination activities at INTEC and other INEEL facilities.

DOE is completing the Idaho HLW & FD EIS in accordance with the requirements of the National Environmental Policy Act (NEPA), which requires Federal agencies to consider possible impacts on the environment before beginning any major action. NEPA does not require agencies to consider the costs of various alternative actions as part of an EIS. However, the DOE-Idaho Operations Office will take cost information into account when developing a preferred alternative.

This Cost Report estimates costs for processing, storing, transporting, and disposing of INEEL HLW and mixed transuranic waste/SBW and closing associated facilities. It provides DOE and the public with information about the long-term financial implications of decisions about managing HLW and mixed transuranic waste/SBW at INEEL. The report is a tool to assist DOE in the selection of treatment technologies and facility disposition solutions. The costs presented in the report are intended to portray the costs of the alternatives relative to each other. Some aspects of the proposed action and the alternatives may change by the time the final Idaho HLW & FD EIS is published. However, DOE does not intend to revise the Cost Report except to respond to public comments.

S.2 Purpose

Data in the Cost Report, along with the analyses in the Idabo HLW & FD EIS, will help DOE make decisions about managing the waste over the next four decades by:

- Helping DOE make relative program cost comparisons among the Idaho HLW & FD EIS alternatives.

- Providing helpful information to DOE in its effort to establish and refine life cycle program costs.
- Fulfilling DOE's commitment from public scoping to make cost information available to the public before the Idaho HLW & FD EIS Record of Decision is issued.
- Expanding on one aspect of the DOE Environmental Management Integration recommendations for HLW management, the Minimum INEEL Processing Alternative.

S.3 Alternatives

The draft Idaho HLW & FD EIS considers the following alternatives, categorized by waste processing or facility disposition. Table S-1 summarizes key attributes of the waste processing alternatives. Key attributes of the facility disposition alternatives are described in the text.

Waste Processing Alternatives

- No Action
- Continued Current Operations
- Separations
- Non-Separations
- Minimum INEEL Processing

Facility Disposition Alternatives

No Action – DOE would not disposition its existing HLW facilities at INTEC.

Clean Closure – Facilities would have hazardous and radiological contaminants, including contaminated equipment, removed from the site or treated to a level that any contaminants would be indistinguishable from background concentrations.

Performance-Based Closure – Closure methods would be decided on a case-by-case basis depending on risk. Facilities would be decontaminated such that residual waste and contaminants no longer pose any unacceptable exposure (or risk) to workers or to the public.

Closure to Landfill Standards – The facility would be closed in accordance with the state and Federal design requirements for closure of landfills. Residual waste would be stabilized to minimize the release of contaminants into the environment.

Table S-1. Summary of key attributes of waste processing alternatives.

Alternative	Waste product	Treatment technology	Transportation/disposal
No Action Alternative	None	None	None. Untreated waste remains at INEEL
Continued Current Operations Alternative	RH TRU waste (from tank heels)	Calcine mixed transuranic waste/SBW Grout mixed transuranic waste/NGLW and tank heel waste	RH TRU containers to WIPP
Separations Alternative			
Full Separations Option	Vitrified HLW LLW Class A type grout	Vitrify separated HLW Grout separated LLW	HLW canisters to a repository LLW containers to onsite or offsite disposal facility
Planning Basis Option	Vitrified HLW LLW Class A type grout RH TRU waste (from tank heels)	Calcine mixed transuranic waste/SBW Vitrify separated HLW Grout separated LLW Grout mixed transuranic waste/NGLW and tank heel waste	HLW canisters to a repository LLW containers to offsite disposal facility RH TRU containers to WIPP
Transuranic Separations Option	RH TRU waste LLW Class C type grout	Solidify separated TRU waste Grout separated LLW	RH TRU containers to WIPP LLW containers to onsite or offsite disposal facility
Non-Separations Alternative			
Hot Isostatic Pressed Waste Option	HIP HLW RH TRU waste (from tank heels)	HIP calcined HLW and mixed transuranic waste/ SBW Grout mixed transuranic waste/NGLW and tank heel waste	HLW canisters to a repository RH TRU containers to WIPP
Direct Cement Waste Option	Cemented HLW RH TRU waste (from tank heels)	Hydroceramic cement of calcined HLW and mixed transuranic waste/SBW Grout mixed transuranic waste/NGLW and tank heel waste	HLW canisters to a repository RH TRU containers to WIPP
Early Vitrification Option	Vitrified HLW RH TRU waste (from mixed transuranic waste/ SBW)	Vitrify calcine Vitrify mixed transuranic waste/SBW	HLW canisters to a repository RH TRU containers to WIPP

Table S-1. (Continued).

Alternative	Waste product	Treatment technology	Transportation/disposal
Minimum INEEL Processing Alternatives			
At INEEL	CH TRU waste from mixed transuranic waste/SBW	CsIX and grout mixed transuranic waste/SBW	CH TRU containers to WIPP HLW canisters to a repository LLW containers to onsite or offsite disposal facility HLW canisters containing calcine to Hanford
At Hanford	Vitrified LLW from calcine Vitrified HLW from calcine	Vitrify separated LLW and HLW	LLW containers to INEEL HLW canisters to INEEL then to a repository

CH = contact-handled; CsIX = cesium ion exchange; HLW = high-level waste; HIP = Hot Isostatic Press; LLW = low-level waste; NGLW = newly generated liquid waste; RH = remote-handled; SBW = sodium bearing waste; TRU = transuranic; WIPP = Waste Isolation Pilot Plant.

Performance-Based Closure with Class A Grout Disposal – Following completion of Performance-Based Closure, the Tank Farm or bin sets would be used to dispose of Class A type grout produced under the Full Separations Option.

Performance-Based Closure with Class C Grout Disposal – Following completion of Performance-Based Closure, the Tank Farm or bin sets would be used to dispose of low-level waste Class C type grout produced under the Transuranic Separations Option.

S.4 Cost Analysis Assumptions and Bases

S.4.1 WASTE PROCESSING ALTERNATIVES

The following general assumptions and bases apply to all waste processing alternative estimates analyzed in this Cost Report:

- Estimates were calculated in 1998 non-discounted dollars (except for discounted cash flow analysis).
- Alternatives and options end in the year 2095 or sooner in some cases.
- Technologies in the alternatives could be deployed and operated as intended.
- Costs for Comprehensive Environmental Response, Compensation, and Liability Act, (CERCLA) cleanup activities in adjacent areas of INTEC were not included in the estimates. Facility disposition costs for Resource Conservation and Recovery Act (RCRA) closures are included.

Other waste processing assumptions were specific to a particular project or activity such as product waste packaging, transportation, waste management, product waste disposal, and long-term or interim storage.

S.4.2 FACILITY DISPOSITION ALTERNATIVES

DOE assumed that:

- Cost estimates address only post-operational activities of existing facilities that are not needed in any of the waste processing alternatives.
- Facilities would be in a condition similar to current conditions when facility disposition begins.
- Closure, deactivation, or decommissioning would be conducted to meet present day applicable RCRA standards if hazardous materials are known to be present.
- Closure, deactivation, or decommissioning would meet applicable DOE orders and regulations.

S.5 Methodology

S.5.1 WASTE PROCESSING ALTERNATIVES

Two methods for estimating were used. Estimates were based on available data:

- Detailed "bottoms-up estimates" based on conceptual design data for engineering projects. These are the types of estimates prepared by LMITCO for activities to be done at INTEC.
- Scaling of costs or specific analogy estimates based on derived unit rates for transportation and disposal projects that are similar to the projects in the Idaho HLW & FD EIS. These are the types of estimates prepared by TtNUS for activities not at the INEEL.

Life cycle costs (LCCs) were prepared for each alternative to illustrate the likely annual costs of the alternatives, the cumulative costs over time, and the net present value of overall investment that would be needed to fully implement an alternative. Like most Federal projects, the INEEL High-Level Waste Program is subject to annual funding requests and commitment of funds, using LCCs shows the funding required to implement these alternatives.

Bottoms-up Estimating

A cost estimating technique that employs a statement of work and set of drawings or specifications to calculate resources to complete a project. Direct labor, equipment, and overhead costs are derived from the information.

S.5.2 FACILITY DISPOSITION ALTERNATIVES

The facility closure cost-estimating methodology specific to INEEL used data from:

- A decontamination and decommissioning (D&D) parametric model that produces cost estimates based on inputs for specific facilities.
- Probabilistic cost estimating, which assesses the risk or measures the probability of cost or schedule overruns and underruns.

S.6 Results

S.6.1 ESTIMATED COSTS FOR WASTE PROCESSING ALTERNATIVES

Costs would range (Figure S-1) from $717 million for the No Action Alternative to $15.2 billion for the Direct Cement Waste Option. These estimates include treatment, storage, transportation, and disposal costs associated with each alternative. The estimates consider such factors as the level of uncertainty including the maturity of the technology, the stage of the project, and other cost-related risks.

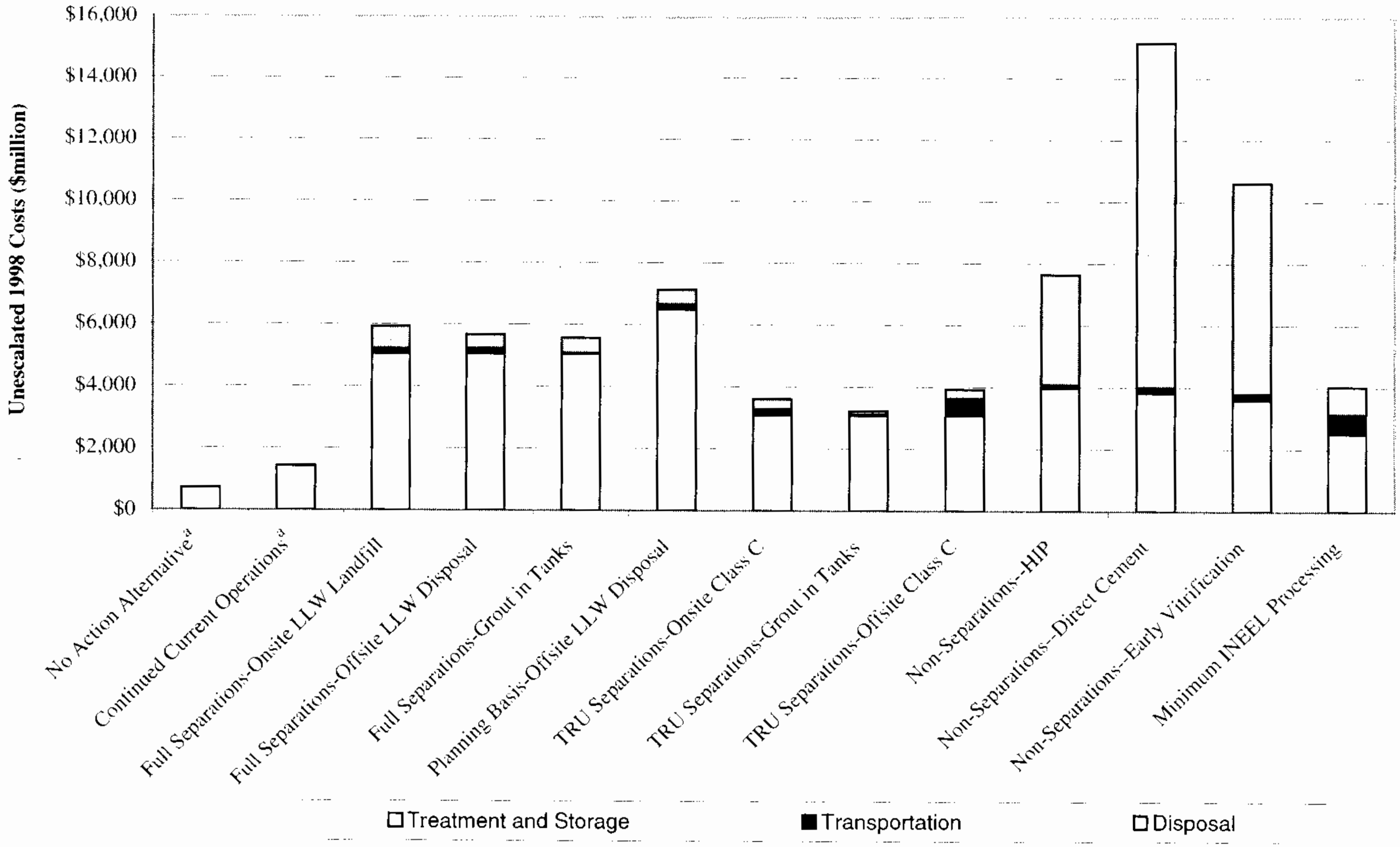
Annual funding. The current level of funding for the INEEL Environmental Management Programs is expected to remain level (see Figure S-2) through 2007. A comparison of the 5-year average annual funding that would be required for the various waste processing alternatives (Figure S-2) shows that only one alternative – No Action – could be implemented at the current level of funding. Implementation of any of the other alternatives would require many times the current funding levels.

Estimated costs for facility disposition alternatives (Table S-2). Estimated costs would range from $135 million to over $3 billion to disposition the INTEC Tank Farm and from $271 million to $536 million for the bin sets, depending on the closure method implemented. Costs of clean closure far exceed those for other facility closure methods (Performance Based or Closure to Landfill Standards).

S.7 Uncertainties

Computer simulations, combined with professional judgment, were used to develop projected cost ranges (high and low) for estimates. Uncertainty factors that may result in cost underruns or overruns include project uniqueness, technological maturity of the processes, the difficulties associated with obtaining environmental permits, and acceptability to stakeholders.

Figure S-1
Waste Processing Alternatives by Cost Component



a. These alternatives do not take the HLW program to an end state.

Figure S-2
Peak Annual Funding Requirements by Alternative
(based on five-year increments)

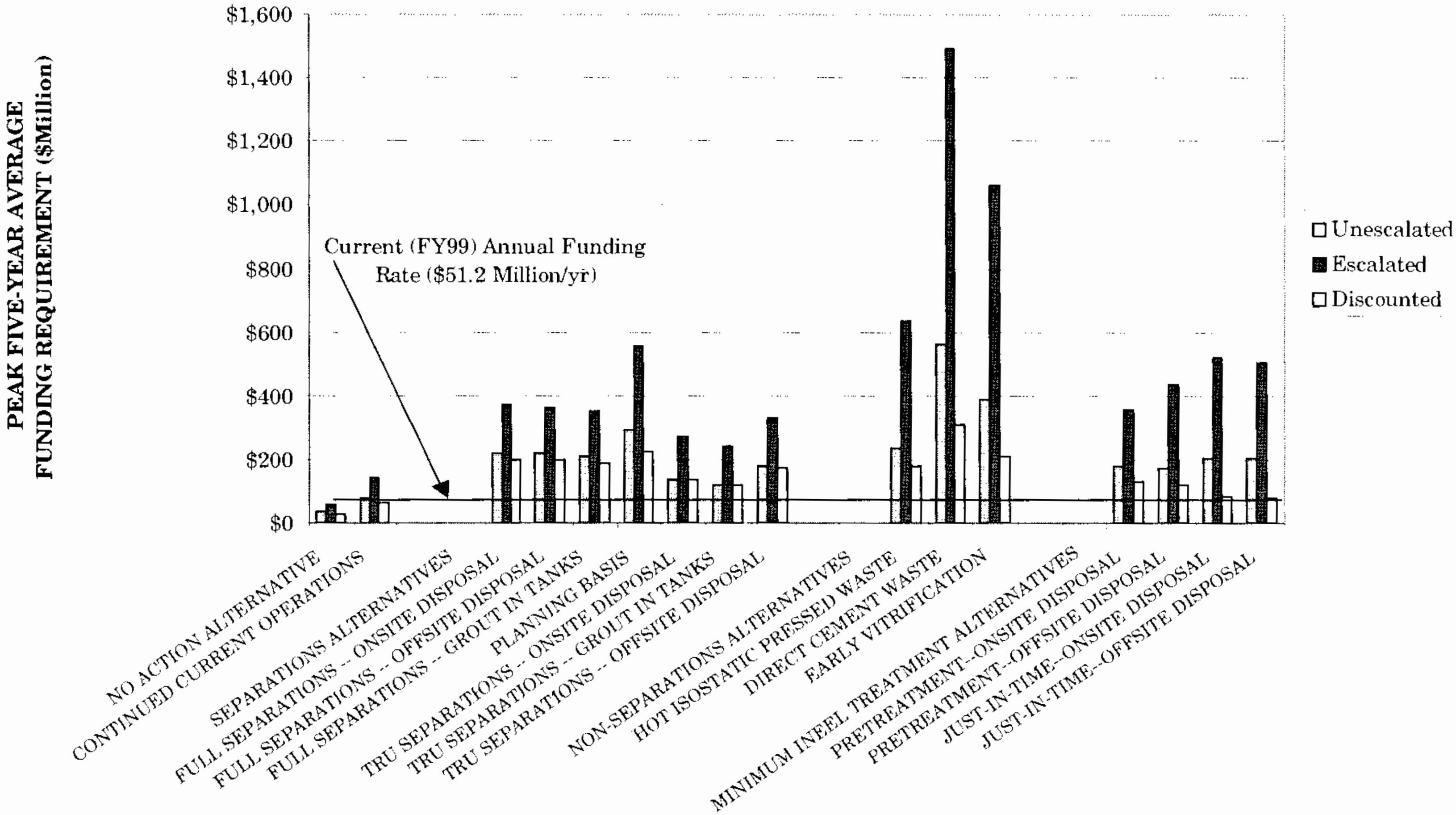


Table S-2. Estimated facility disposition costs by closure method.

Facility name	Estimated cost in 1998 millions of dollars by closure method: Clean Closure	Performance-Based Closure	Closure to Landfill Standards
Tank Farm	$3,173	$169	$135
Bin Sets	$ 536	$460	$271
Fuel Processing Building and Related Facilities	(a)	$ 57	$ 46
New Waste Calcining Facility	(a)	$ 42	$ 39

a. The Clean Closure Alternative was not evaluated for this facility.

S.8 Sensitivities

The results of a cost estimate are dependent on the assumptions and bases that are used. Several aspects of the estimates were reviewed in a sensitivity analysis to determine if changes in key assumptions would affect the relative outcome of the cost estimates for the alternatives. The four elements considered were timing of the actions, repository cost, transportation, and regulatory framework as described in Section 8.0. Transportation and regulatory changes were determined not to cause a change in the cost ranking of the alternatives as far as the potential changes were defined. Changes in the timing of actions and repository/disposal costs were found to potentially affect the cost ranking of the alternatives.

S.9 Conclusions

- The Separations Alternative, Transuranic Separations Option with Grout in Tanks is the lowest cost option that would produce a waste form that might be acceptable for disposal.

- The Non-Separations Alternative, Direct Cement Option is the highest cost option. However, the No Action and Continued Current Operations Alternatives would have other future costs beyond the year 2095 that have not been estimated in the Cost Report because final waste forms would not be produced under these alternatives. As a result, the No Action and Continued Current Operations Alternatives may ultimately represent the highest cost alternatives.

- All waste processing alternatives except No Action would require a substantial increase in funding over current levels to be implemented.

- The amount of HLW and mixed transuranic waste/SBW for disposal associated with a waste-processing alternative is the major determinant of total alternative cost. Alternatives that produce a smaller number of HLW canisters (i.e., Separations) have a significant cost advantage.

- Transporting wastes for treatment or disposal at other DOE sites might be more cost effective than duplication of treatment or disposal facilities at INEEL.

- All of the waste processing cost estimates rely to some degree on the availability of waste disposal facilities that have not opened or may not be available to accept waste consistent with the assumed schedules for the alternatives.

Closure to Landfill Standards is the lowest cost alternative for facility disposition. Costs would be much higher if clean closure methods are used for the Tank Farm and bin sets.

1.0 INTRODUCTION AND BACKGROUND

This report presents and compares cost estimates to support the Idaho High-Level Waste and Facilities Disposition EIS (Idaho HLW & FD EIS). The Idaho HLW & FD EIS analyzes several waste processing alternatives and facility disposition alternatives for the Idaho National Engineering and Environmental Laboratory (INEEL). This EIS is being written to analyze alternatives for the INEEL High-Level Waste Program at the Idaho Nuclear Technology and Engineering Center (INTEC), formerly known as the Idaho Chemical Processing Plant.

The original purpose of INTEC was to be a one-of-a-kind processing facility for government-owned nuclear fuels from research and defense reactors. Until 1991 when INTEC stopped reprocessing spent nuclear fuel, rare gases and enriched uranium were recovered for reuse from spent nuclear fuel. INTEC's current purpose is to:

- Receive and store U.S. Department of Energy (DOE)-assigned spent nuclear fuels
- Manage HLW until disposal in a repository
- Develop technologies for the final disposition of spent nuclear fuel, HLW, and mixed transuranic waste (sodium-bearing waste/SBW)
- Develop and apply technologies to minimize waste generation and manage radioactive and hazardous wastes

Costs presented in this report include those for waste treatment and storage, transportation, waste disposal, and closure of existing and new facilities proposed in the Idaho HLW & FD EIS. DOE analyzes and presents estimated costs to help government decision-makers compare the alternatives. The costs presented in the report are intended to portray the costs of the alternatives relative to each other. Some aspects of the proposed action and the alternatives may change by the time the final Idaho HLW & FD EIS is published. However, DOE does not intend to revise the Cost Report except to respond to public comments.

2.0 PURPOSE

This report provides DOE and the public with information on the long-term cost implications of future DOE decisions on the management of HLW and SBW at the INEEL. SBW is mixed transuranic waste and was created primarily from decontamination activities at INTEC and other INEEL facilities. This report is also a tool to help DOE make decisions that incorporate cost-effective selection of treatment technologies and waste storage solutions. Conclusions are detailed in Section 9 of this report. Table 1 and Figures 1 through 9 summarize the Idaho HLW & FD EIS alternatives.

Decisions made today could impact future costs, especially if eventual decisions result in a substantial commitment to future technology development or construction of new waste treatment facilities. Some key decisions may not be made for several years. However, waste processing alternatives that require substantial technical development require an early decision to allow enough time to conduct additional research and testing and to avoid discarding a sound but immature technology option.

For each alternative and option, this report considers capital costs for new facilities or upgrades to existing facilities, operation and maintenance costs for existing and new facilities, decontamination and decommissioning costs for new facilities, and transportation and disposal costs. The total system life cycle costs (LCCs) for each alternative and option are also addressed. Because of uncertainties in waste treatment technologies and availability of waste disposal facilities, DOE deemed it prudent to emphasize a comparison of costs for alternatives and annual funding needs rather than focus only on the total dollar cost of alternatives.

The Cost Report fulfills four purposes:

- Helps DOE make relative program cost comparisons among the Idaho HLW & FD EIS alternatives
- Provides helpful information to DOE in its effort to establish and refine life cycle program costs
- Fulfills DOE's commitment to make cost information available to the public before the Idaho HLW & FD EIS Record of Decision is issued
- Further develops one aspect of the DOE Environmental Management Integration recommendations for HLW management, the treatment of INEEL HLW at the Hanford Site in Richland, Washington

This Cost Report presents cost comparisons of the waste processing alternatives that include total estimated costs for a full range of management activities including interim storage, transportation, treatment, and disposal. The LCCs (pre-operational, operational, and post-operational) for the alternatives, the annual funding requirements, and the net present value of the alternatives provide additional information for the decisionmaker. DOE made a commitment to the public to study the costs of the alternatives based on comments that were received during the Idaho HLW & FD EIS scoping process. DOE has published this Cost Report and made it available to the public at the same time as the Idaho HLW & FD EIS.

> **Net Present Value**
> Net present value was calculated for all of the Idaho HLW & FD EIS alternatives and options. This means that all expenditures projected for the future were developed in 1998 dollars and were escalated then discounted to the present time. Finally, the costs were summed as if the costs were all incurred simultaneously in the present.

DOE will present the results of the analysis of an alternative that would take advantage of waste treatment facilities that would be constructed at another DOE site. The example that was analyzed specifically in the Idaho HLW & FD EIS and in this Cost Report is to send INEEL HLW calcine to the Tank Waste Remediation System (TWRS) facilities at the Hanford Site in Richland, Washington for separation into HLW and low-level waste (LLW) fractions and vitrification. This alternative would minimize the need for new waste treatment facilities to be built in Idaho. Treatment activities for all other alternatives would be performed at INEEL.

3.0 DESCRIPTION OF ALTERNATIVES

The Idaho HLW & FD EIS analyzes waste processing and facility disposition alternatives including implementation options and various scenarios. The alternatives encompass transportation, waste treatment, interim storage, disposal, and facility disposition. The set of alternatives and related technologies for analysis in the Idaho HLW & FD EIS and this Cost Report were selected by a multidisciplinary DOE panel with input from the public, regulators, INEEL Citizen Advisory Board, Native American Tribes, internal stakeholders, and other interested parties.

3.1 Waste Management Alternatives

The Idaho HLW & FD EIS considers the following five waste processing alternatives. Some of the waste processing alternatives have multiple options for implementation, specifically:

- No Action Alternative
- Continued Current Operations Alternative
- Separations Alternative
  - Full Separations Option – Onsite LLW Class A type grout disposal
  - Full Separations Option – Offsite LLW Class A type grout disposal
  - Full Separations Option – Grout in tanks
  - Planning Basis Option
  - Transuranic Separations Option – Onsite LLW Class C type grout disposal

  - Transuranic Separations Option – Grout in tanks
  - Transuranic Separations Option – Offsite LLW Class C type grout disposal

- Non-Separations Alternative
  - Hot Isostatic Pressed Waste Option
  - Direct Cement Waste Option
  - Early Vitrification Option

- Minimum INEEL Processing Alternative
  - Just-In-Time Shipping Scenario– onsite disposal of LLW
  - Just-In-Time Shipping Scenario – offsite disposal of LLW
  - Interim Storage Shipping Scenario – onsite disposal of LLW
  - Interim Storage Shipping Scenario – offsite disposal of LLW

This Cost Report considers 16 options or scenarios. Table 1 shows the specific implementation options for the alternatives. Table 2 lists the waste treatment and related facilities that DOE would construct for the various alternatives. Each alternative or option uses a different set of facilities and generates a unique combination of waste products. Figures 1 through 9 provide conceptual flow diagrams and timelines for the major activities associated with each alternative/option. The alternatives and options are described in more detail in Chapter 3 of the Idaho HLW & FD EIS.

Table 3 identifies several activities related to disposal of waste at facilities not located at INEEL. These projects are included in this report even though they were not analyzed for environmental impacts in the Idaho HLW & FD EIS so that the LCCs of the options can be compared. The environmental impacts of waste disposal at the other facilities have been or soon will be analyzed in other documents as noted below:

- HLW – *Draft Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada* (DOE 1999a)

- Transuranic (TRU) waste– *Waste Isolation Pilot Plant Supplemental EIS* (DOE 1997a)

- Low-Level Waste – Radioactive Materials License reviews by the State of Utah for the Envirocare Site and by the State of South Carolina for the Barnwell site

Table 1. Summary of key attributes of the waste processing alternatives.

Alternatives	Waste Product	Primary treatment technology	Product waste disposal	Transportation/Disposal	Indefinite or interim storage[a]
No Action Alternative	None	None	Untreated waste remains at INEEL	None. Untreated waste remains at INEEL	Untreated mixed transuranic waste/SBW and mixed HLW calcine stored indefinitely in Tank Farm and bin sets, respectively
Continued Current Operations Alternative	RH TRU waste (from tank heels)	Calcine mixed transuranic waste/SBW Grout mixed transuranic waste/NGLW[b] and tank heel waste	RH TRU waste to WIPP	RH TRU containers to WIPP	Mixed HLW and mixed transuranic waste/SBW calcine stored indefinitely in bin sets
Separations Alternative					
Full Separations Option	Vitrified HLW LLW Class A type grout	Vitrify separated HLW fraction Grout separated LLW fraction	Vitrified HLW to a repository LLW Class A type grout to: New onsite disposal facility or Tank Farm and bin sets or offsite disposal facility	HLW canisters to a repository LLW containers to onsite or offsite disposal facility	Vitrified HLW storage pending disposal at a repository
Planning Basis Option	Vitrified HLW LLW Class A type grout RH TRU waste (from tank heels)	Calcine mixed transuranic waste/SBW Vitrify separated HLW fraction Grout separated LLW fraction Grout mixed transuranic waste/NGLW[b] and tank heel waste	Vitrified HLW to a repository LLW Class A type grout to offsite disposal facility RH TRU waste to WIPP	HLW canisters to a repository LLW containers to offsite disposal facility RH TRU containers to WIPP	Vitrified HLW storage pending disposal at a repository
Transuranic Separations Option	RH TRU waste LLW Class C type grout	Solidify separated TRU fraction Grout separated LLW fraction	RH TRU waste to WIPP LLW Class C type grout to: New onsite disposal facility or Tank Farm and bin sets or offsite disposal facility	RH TRU containers to WIPP LLW containers to onsite or offsite disposal facility	None
Non- Separations Alternative					
Hot Isostatic Pressed Waste Option	HIP HLW RH TRU waste (from tank heels)	HIP calcined HLW and mixed transuranic waste/SBW Grout mixed transuranic waste/NGLW[b] and tank heel waste	HIP HLW to a repository RH TRU waste to WIPP	HLW canisters to a repository RH TRU containers to WIPP	HIP HLW storage pending disposal at a repository.

Table 1. (Continued).

Alternatives	Waste Product	Primary treatment technology	Product waste disposal	Transportation/Disposal	Indefinite or interim storage[a]
Direct Cement Waste Option	Cemented HLW RH TRU waste (from tank heels)	Hydroceramic cement of calcined HLW and mixed transuranic waste/SBW Grout mixed transuranic waste/NGLW[b] and tank heel waste	Cemented HLW to a repository RH TRU waste to WIPP	HLW canisters to a repository RH TRU containers to WIPP	Cemented HLW storage pending disposal at a repository
Early Vitrification Option	Vitrified HLW RH TRU waste (from mixed transuranic waste/SBW)	Vitrify calcine Vitrify mixed transuranic waste	Vitrified HLW to a repository RH TRU waste to WIPP	HLW canisters to a repository RH TRU containers to WIPP	Vitrified HLW storage pending disposal at a repository
Minimum INEEL Processing Alternative					
At INEEL	CH TRU waste from mixed transuranic waste/SBW	CsIX and grout mixed transuranic waste	CH TRU waste to WIPP Vitrified LLW to new onsite disposal facility or an offsite commercial disposal facility Vitrified HLW to a repository	CH TRU containers to WIPP HLW canisters to a repository LLW containers to onsite or offsite disposal facility HLW canisters containing calcine to Hanford	Vitrified HLW storage pending disposal at a repository
At Hanford	Vitrified LLW from calcine Vitrified HLW from calcine	Vitrify separated LLW fraction and HLW fraction	Vitrified LLW fraction returned to INEEL Vitrified HLW fraction returned to INEEL	LLW containers to INEEL HLW canisters to INEEL	None

a. Chapter 5 of the Idaho HLW & FD EIS presents annualized impacts for these storage activities through the period of institutional control.

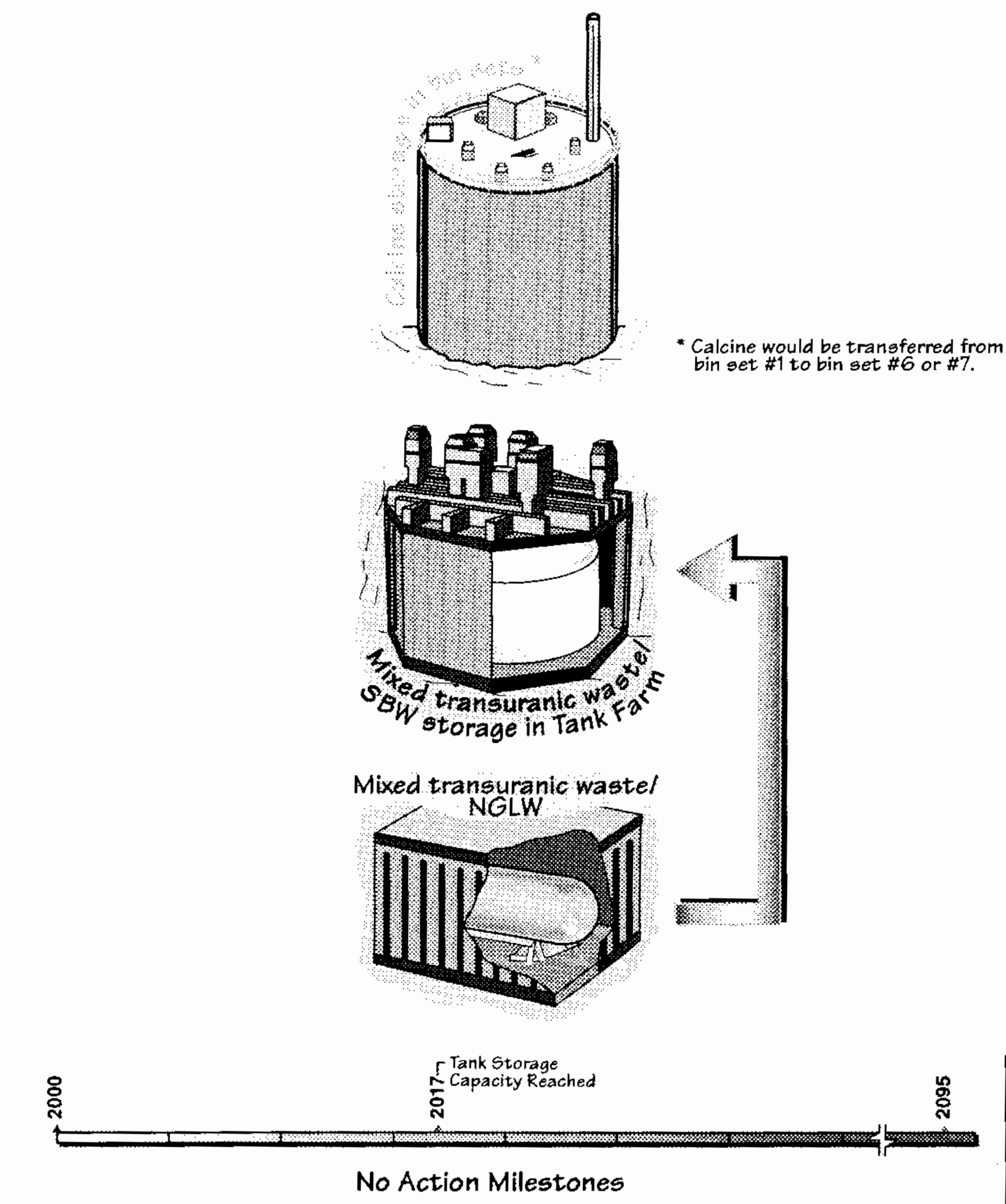
b. For purposes of analysis, mixed transuranic waste (NGLW) grout was assumed to be managed as low-level (process) waste.

CH = contact-handled; CsIX = cesium ion exchange; HIP = Hot Isostatic Pressed; LLW = low-level waste; NGLW = newly-generated liquid waste; RH = remote-handled; TRU = transuranic; WIPP = Waste Isolation Pilot Plant.

Table 2. Proposed INTEC facilities associated with the waste processing alternatives.

	No Action Alternative	Continued Current Operations Alternative	Full Separations Option	Planning Basis Option	Transuranic Separations Option	Hot Isostatic Pressed Waste Option	Direct Cement Waste Option	Early Vitrification Option	Minimum INEEL Processing Alternative
Calcine Retrieval and Transport System (bin set 1 only)	●	●	–	–	–	–	–	–	–
Calcine Retrieval and Transport System	–	–	●	●	●	●	●	●	●
NGLW Treatment Facility	–	●	–	●	–	●	●	–	–
Waste Separations Facility	–	–	●	●	–	–	–	–	–
Transuranic Separations Facility	–	–	–	–	●	–	–	–	–
Vitrification Plant	–	–	●	●	–	–	–	–	–
Class A Grout Plant	–	–	●	●	–	–	–	–	–
Class C Grout Plant	–	–	–	–	●	–	–	–	–
Hot Isostatic Press Facility	–	–	–	–	–	●	–	–	–
Cement Facility	–	–	–	–	–	–	●	–	–
Early Vitrification Facility	–	–	–	–	–	–	–	●	–
Interim Storage Facility	–	–	●	●	–	●	●	●	●
Low-Activity Waste Disposal Facility	–	–	●	–	●	–	–	–	●[a]
Calcine Packaging Facility	–	–	–	–	–	–	–	–	●
SBW and NGLW Treatment Facility	–	–	–	–	–	–	–	–	●
New Analytical Laboratory	–	–	●	●	●	●	●	●	●
Waste Treatment Pilot Plant	–	–	●	●	●	●	●	●	●

a. For vitrified low-level waste fraction returned from Hanford Site.
● indicates the proposed facility is associated with the alternative.
Dash indicates the proposed facility is not required.
NGLW = newly generated liquid waste.

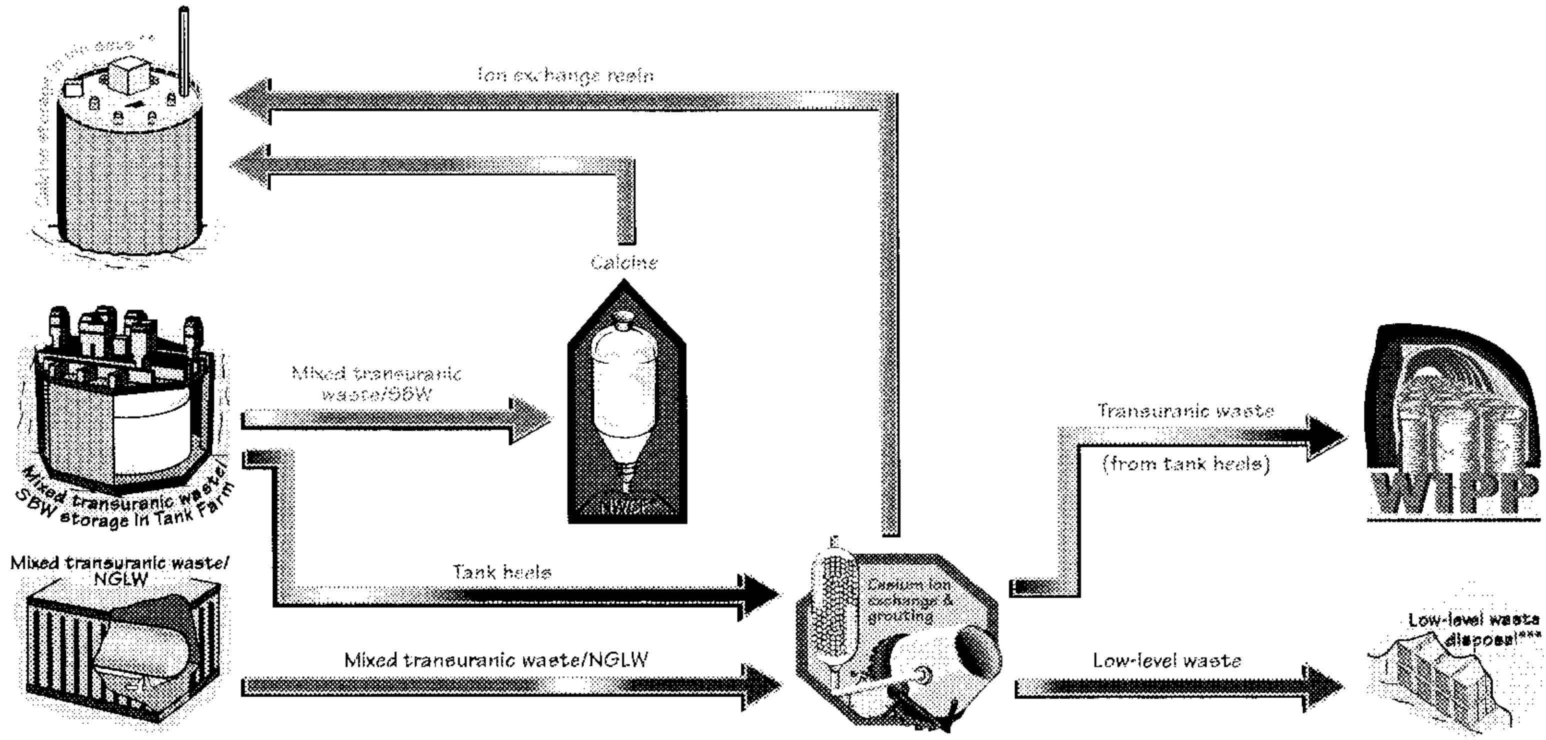


LEGEND

SBW Mixed transuranic waste/ sodium-bearing waste

NGLW Mixed transuranic waste/ newly generated liquid waste

FIGURE 1.
No Action Alternative.



LEGEND

LLW	Low-level waste
NGLW	Mixed transuranic waste/ newly generated liquid waste
NWCF	New Waste Calcining Facility
SBW	Mixed transuranic waste/ sodium-bearing waste
WIPP	Waste Isolation Pilot Plant

* Including high-temperature and maximum achievable control technology upgrades.

** Calcine would be transferred from bin set #1 to bin set #6 or #7.

*** Location may be determined by Waste Management Programmatic EIS decision and may be on or off the INEEL.

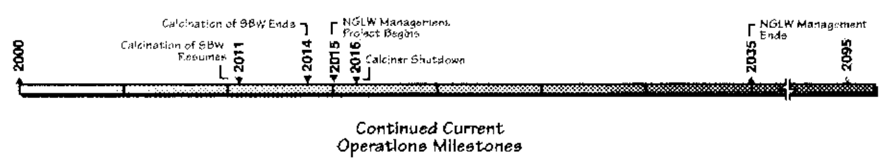
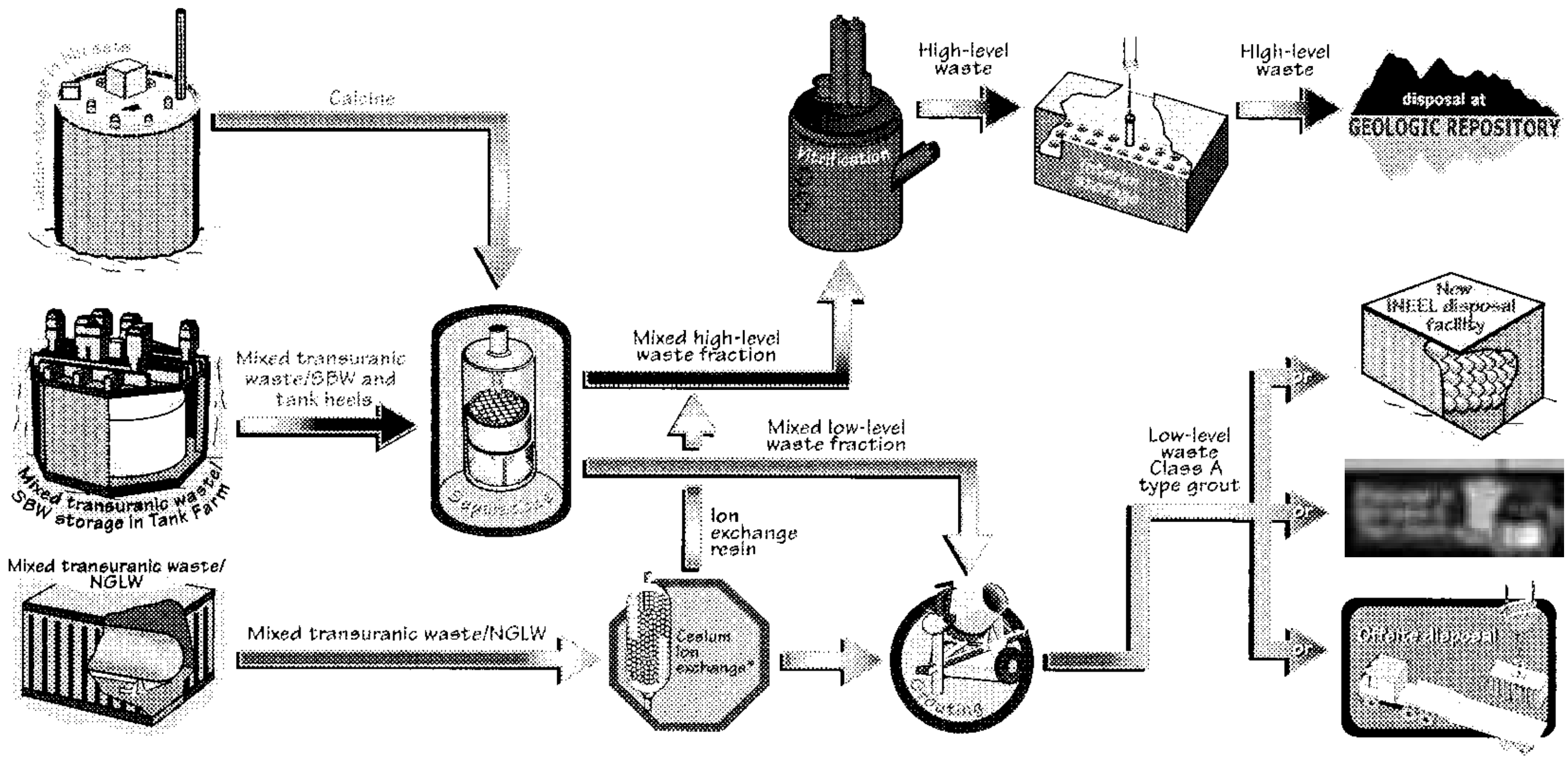


FIGURE 2.
Continued Current Operations Alternative.



LEGEND

NGLW Mixed transuranic waste/ newly generated liquid waste

SBW Mixed transuranic waste/ sodium-bearing waste

* Some mixed transuranic waste (newly generated liquid waste) may not need to be treated with ion exchange and could be sent directly to the grouting facility.

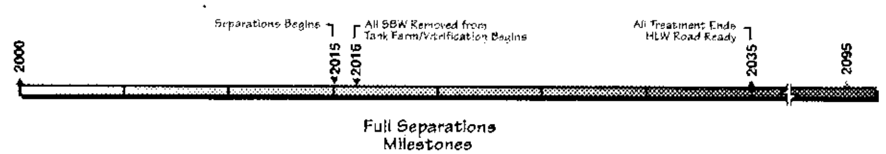
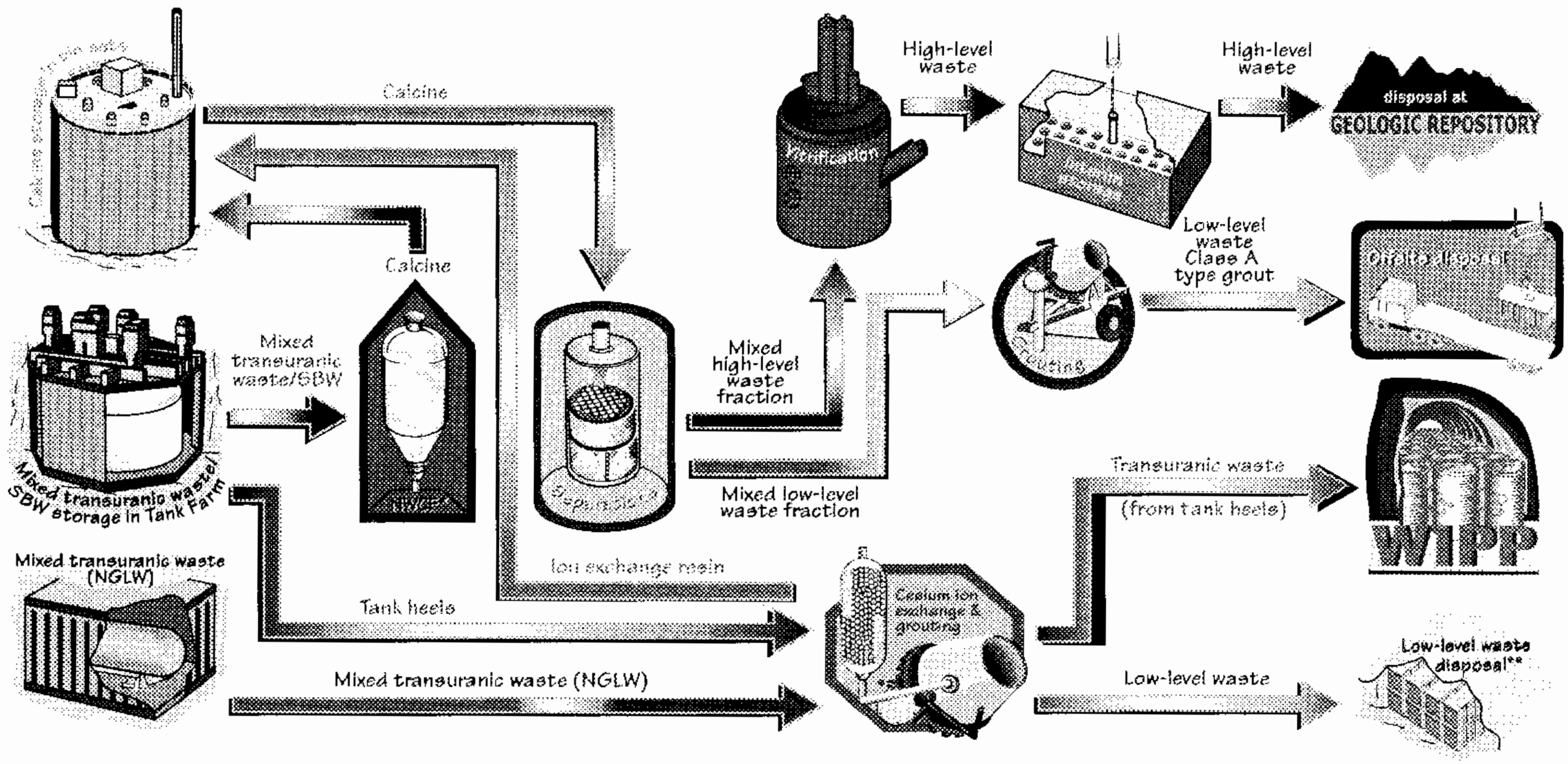


FIGURE 3.
Full Separations Option.



LEGEND

NGLW Mixed transuranic waste (newly generated liquid waste)

NWCF New Waste Calcining Facility

SBW Mixed transuranic waste/ sodium-bearing waste

WIPP Waste Isolation Pilot Plant

* Including high-temperature and maximum achievable control technology upgrades.

** Location may be determined by Waste Management Programmatic EIS decision and may be on or off the INEEL.

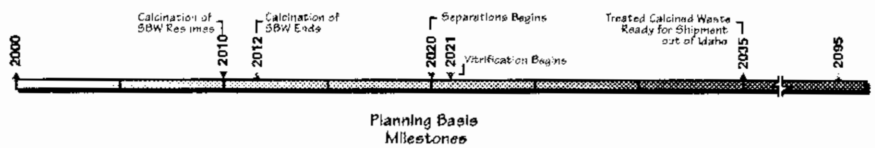
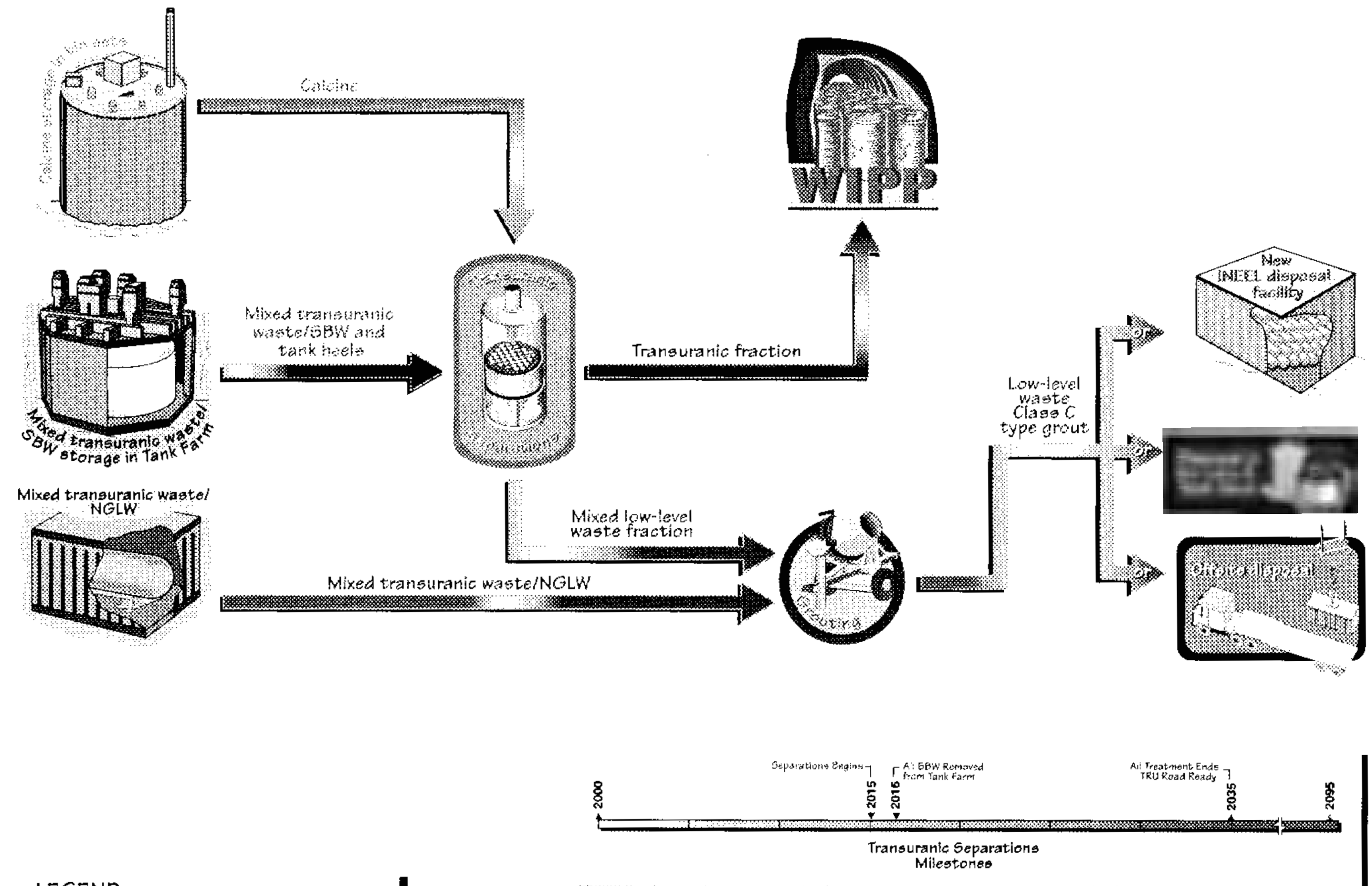


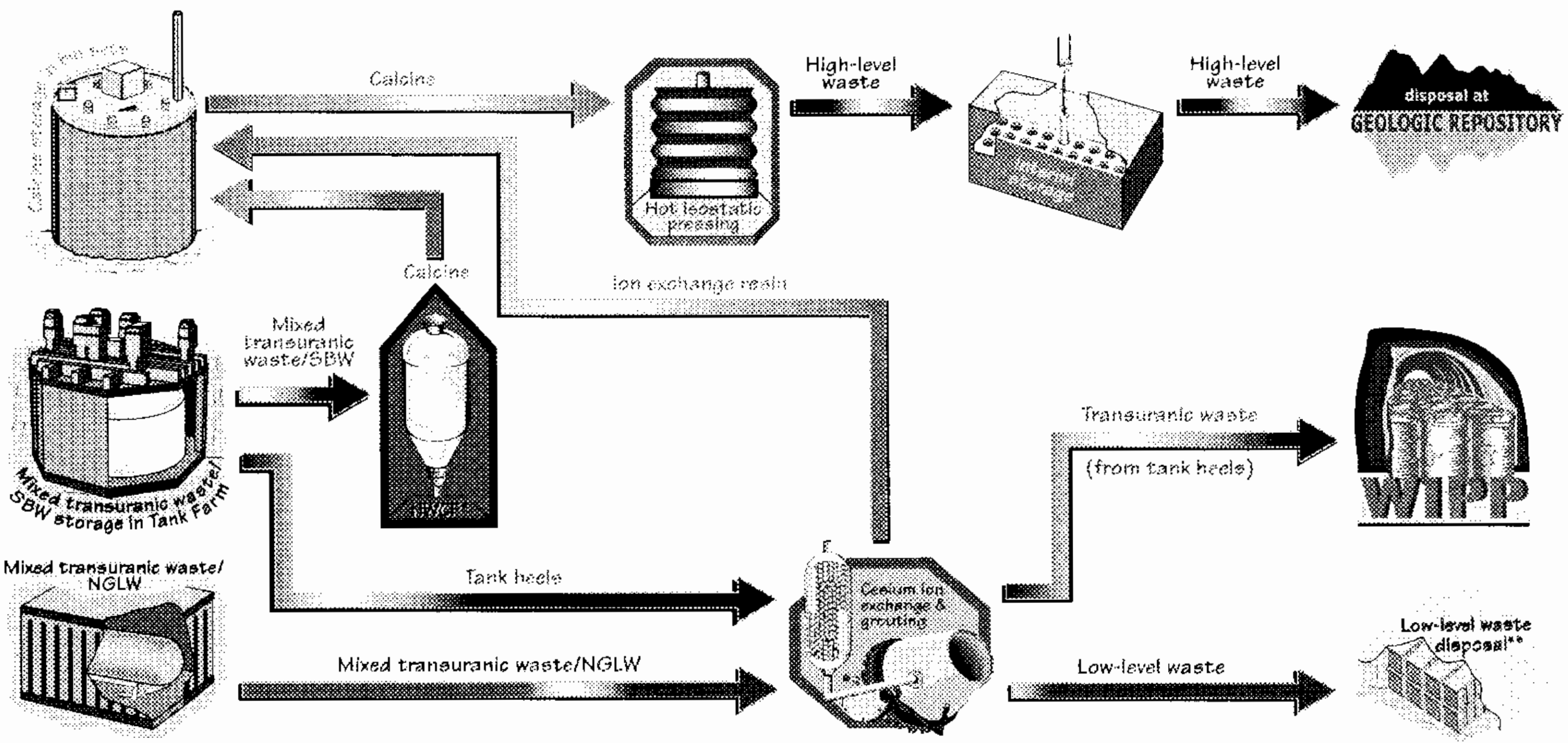
FIGURE 4.
Planning Basis Option.



LEGEND

NGLW	Mixed transuranic waste/ newly generated liquid waste
SBW	Mixed transuranic waste/ sodium-bearing waste
WIPP	Waste Isolation Pilot Plant

FIGURE 5.
Transuranic Separations Option.



LEGEND

NGLW	Mixed transuranic waste/ newly generated liquid waste
NWCF	New Waste Calcining Facility
SBW	Mixed transuranic waste/ sodium-bearing waste
WIPP	Waste Isolation Pilot Plant

* Including high-temperature and maximum achievable control technology upgrades.

** Location may be determined by Waste Management Programmatic EIS decision and may be on or off the INEEL.

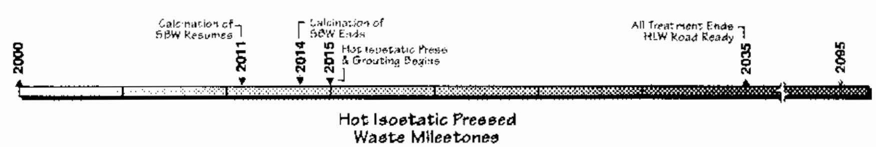
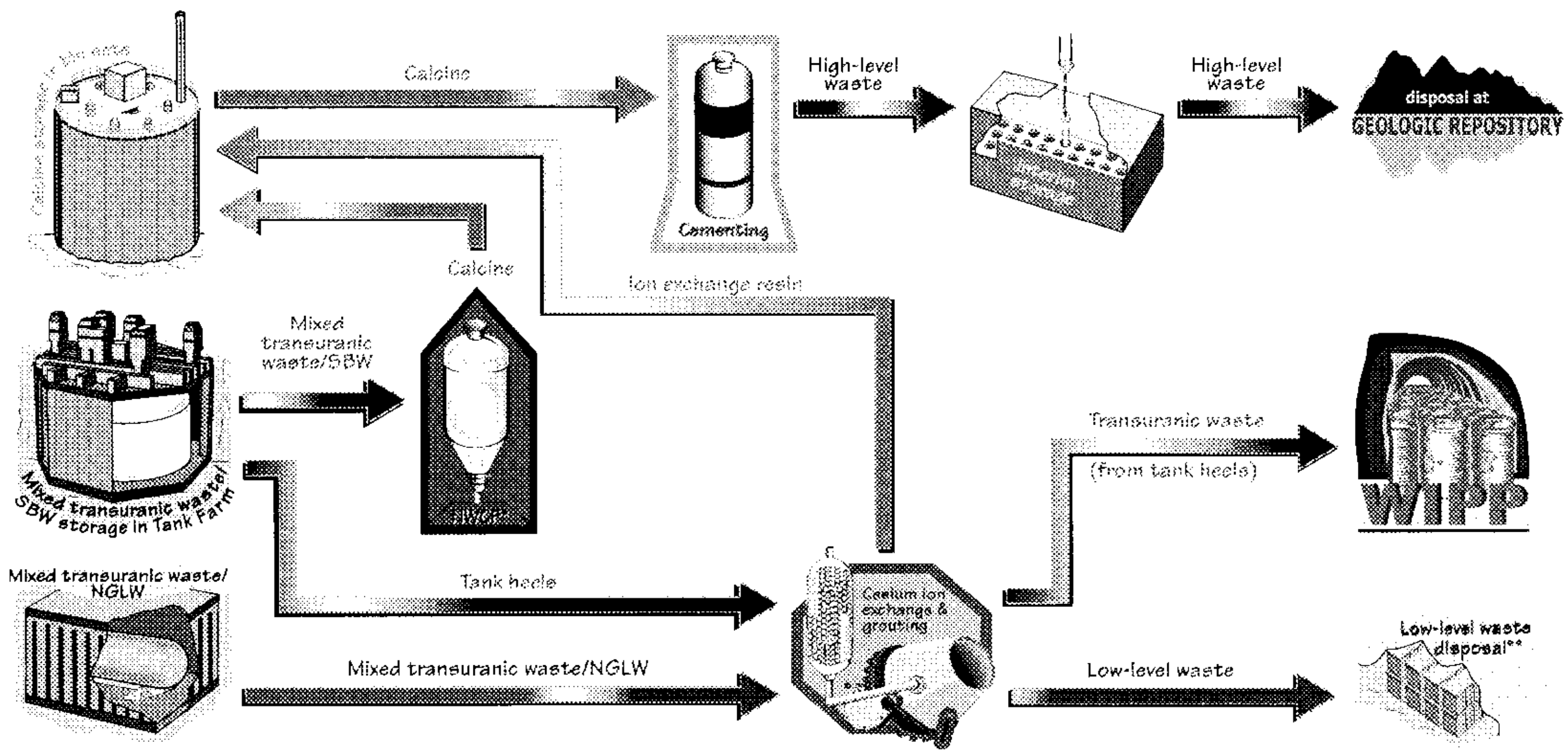


FIGURE 6.
Hot Isostatic Pressed Waste Option.

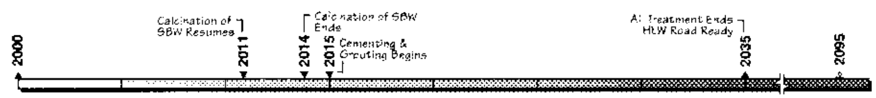


LEGEND

NGLW	Mixed transuranic waste/ newly generated liquid waste
NWCF	New Waste Calcining Facility
SBW	Mixed transuranic waste/ sodium-bearing waste
WIPP	Waste Isolation Pilot Plant

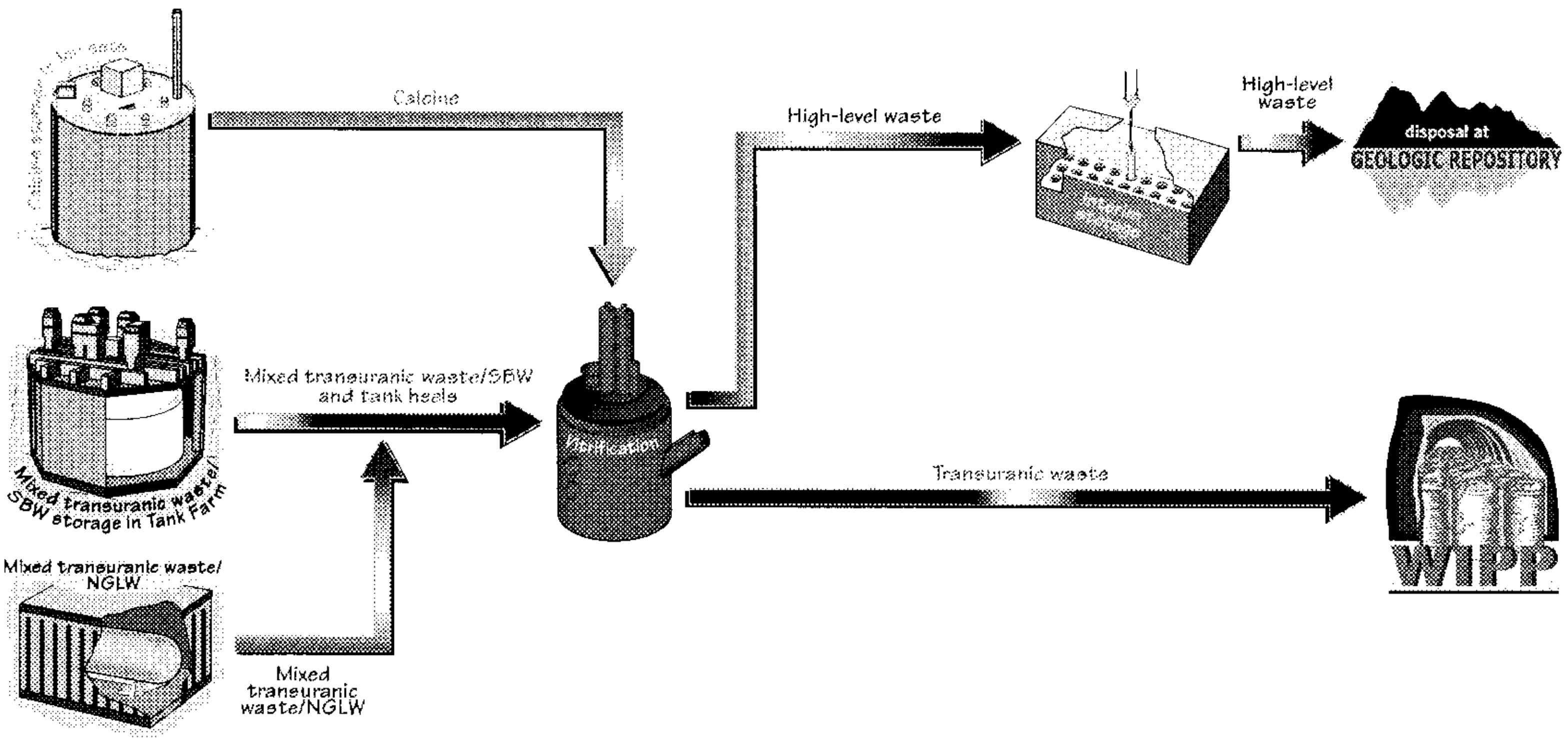
* Including high-temperature and maximum achievable control technology upgrades.

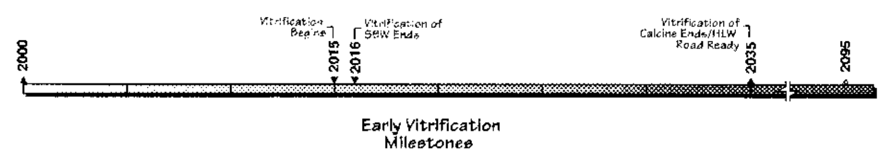
** Location may be determined by Waste Management Programmatic EIS decision and may be on or off the INEEL.



Direct Cement Waste Milestones

FIGURE 7.
Direct Cement Waste Option.

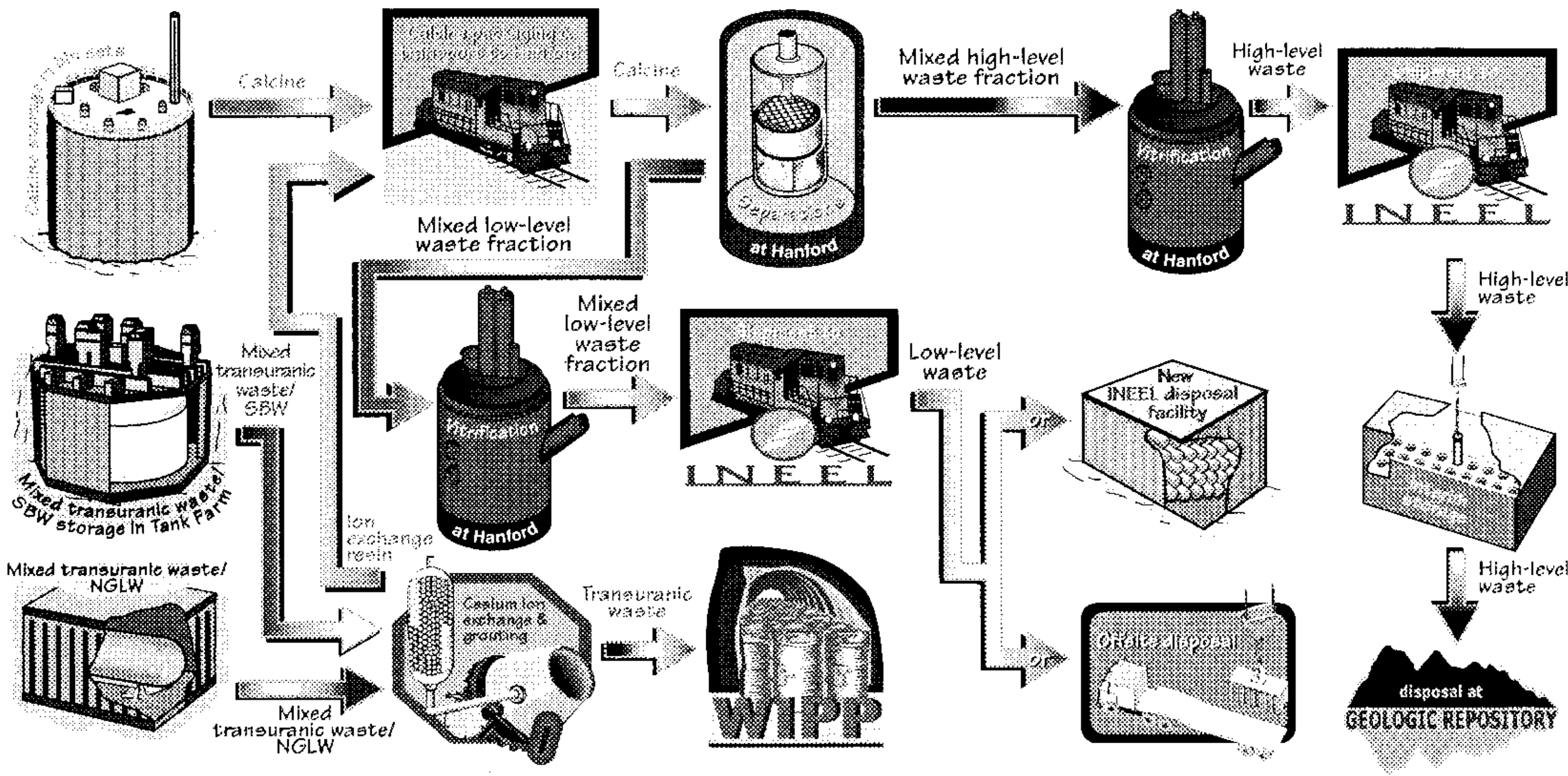


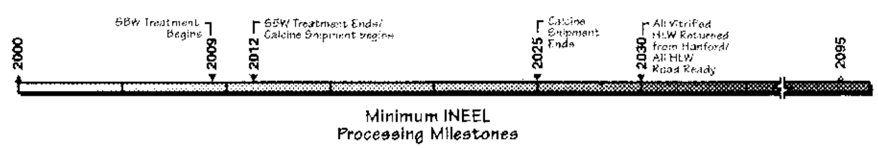


LEGEND

NGLW	Mixed transuranic waste/ newly generated liquid waste
NWCF	New Waste Calcining Facility
SBW	Mixed transuranic waste/ sodium-bearing waste
WIPP	Waste Isolation Pilot Plant

FIGURE 8.
Early Vitrification Option.





LEGEND

NGLW	Mixed transuranic waste/ newly generated liquid waste
SBW	Mixed transuranic waste/ sodium-bearing waste
WIPP	Waste Isolation Pilot Plant

FIGURE 9.
Minimum INEEL Processing Alternative.

Table 3. Offsite disposal activities that were not analyzed in the Idaho HLW & FD EIS but were included in the Cost Report to show life cycle costs.

Project	Alternative[a]
Vitrified HLW Disposal Costs at a Repository	FS, PB, MIN, EV
Class A[b] Type Grout Offsite Disposal	FS, PB, MIN
Class C Type Grout Offsite Disposal	TS
Transuranic Waste Disposal at WIPP[c]	TS
HIP Waste Disposal at a Repository	HIP
Cemented HLW Disposal Costs at a Repository	DC
Disposal of Vitrified SBW at WIPP	EV
Contact Handled Transuranic Waste Disposal at WIPP	MIN
Newly Generated Liquid Waste Management and Tank Farm Heel Waste (Remote-Handled Waste) Disposal at WIPP	CCO, PB, HIP, DC

a. CCO = Continued Current Operations Alternative. FS = Full Separations Option, PB = Planning Basis Option, TS = Transuranic Separations Option, HIP = Hot Isostatic Pressed Waste Option, DC = Direct Cement Waste Option, EV = Early Vitrification Option, MIN = Minimum INEEL Processing Alternative.

b. Waste can be stabilized in several ways including grout. Class A type grout generally has a lower level of radioactivity than Class C type grout.

c. WIPP = Waste Isolation Pilot Plant.

3.2 Facility Disposition Alternatives

In addition to the waste processing alternatives, DOE is evaluating facility disposition for existing facilities that will not be used in the future. There are six potential facility disposition alternatives in the Idaho HLW & FD EIS: (1) No Action – DOE would not disposition the existing facilities, (2) Clean Closure, (3) Performance-Based Closure, (4) Closure to Landfill Standards, (5) Performance-Based Closure with Class A Grout Disposal, and (6) Performance-Based Closure with Class C Grout Disposal.

Facility Disposition

Facility disposition would include activities performed under multiple regulatory programs to address INTEC facilities that no longer have a mission and must be placed in a condition consistent with future land use decisions and end-state planning for the INEEL. Some of the activities that would be encompassed by the facility disposition alternatives include:

Deactivation – Removing potentially hazardous (non-waste) materials from the process vessels and transport systems, de-energizing power supplies, disconnecting or reloading utilities, and other actions to place the facility in an interim state that requires minimal surveillance and maintenance.

Decommissioning – Decontamination of facilities that have been deactivated. This may include demolition of the facility and removal of the rubble from the site or entombment by means such as collapsing the aboveground portions of the structure into its below-grade levels and capping the contaminated rubble in place or constructing containment structures around the facility.

Facility disposition activities are intended to reach an end state where the contamination has been removed, contained, or reduced such that the level of risk associated with the residual contamination is no longer considered a threat to human health or the environment. At that time, DOE could either reuse the facilities for new missions or transfer control of the facilities to others.

For existing major HLW facilities, DOE has determined which of the facility disposition alternatives would be most appropriate for each facility. The determination of the applicable disposition method to use was based on the facility and residual waste characteristics as noted in Table 4. Current radioactive waste levels at the Tank Farm and bin sets comprise about 99 percent of the radioactivity at INTEC. Consequently, the overall residual risk at INTEC would not change significantly from the contribution from all other facilities currently or formerly used in the processing of INEEL HLW.

Table 4. Facility disposition closure methods.

	Facility Disposition Alternative or Closure Method				
Facility Group	Clean Closure	Performance-Based Closure	Closure to Landfill Standards	Performance-Based Closure with Class A Grout Disposal	Performance-Based Closure with Class C Grout Disposal
Tank Farm and Related Facilities					
Tank Farm[a]	●	●	●	●	●
Related Facilities			●		
Bin Sets and Related Facilities					
Bin Sets[b]	●	●	●	●	●
Related Facilities			●		
Process Equipment Waste Evaporator and Related Facilities					
Process Equipment Waste Evaporator			●		
Related Facilities[c]	●[d]		●		
Fuel Processing Building and Related Facilities					
Fuel Processing Building		●	●		
Related Facilities		●	●		
Fluorinel and Storage Facility and Related Facilities					
Fluorinel Dissolution Process and Fuel Storage Facility		●			
Fluorinel Dissolution Process and Fuel Storage Facility Stack	●				
Transport Lines Group					
Process Off-Gas Lines and Process (Dissolver) Transport Lines			●		
High-Level Liquid Waste (Raffinate) Lines and Calcine Solids Transport Lines		●			
Other HLW Facilities					
New Waste Calcining Facility[e]		●	●		
Remote Analytical Laboratory		●			

a. The INTEC Tank Farm consists of underground storage tanks, concrete tank vaults, waste transfer lines, valve boxes, valves, airlift pits, cooling equipment, and several small buildings containing instrumentation and valves for the waste tanks.

b. The bin sets consist of ancillary structures, instrument rooms, filter rooms, cyclone vaults, and stacks.

c. Includes the Blower Building, West Side Waste Holdup, Atmospheric Protection Building, Main Stack, Pre-Filter Vault, Liquid Effluent Treatment and Disposal Facility, and Process Equipment Waste Evaporator Condensate Lines and Cell Floor Drain Lines.

d. Two related facilities are analyzed for Clean Closure; all the others are Closure to Landfill Standards.

e. Includes Organic Solvent Disposal Building.

3.2.1 DESCRIPTION OF FACILITY DISPOSITION ALTERNATIVES

The cost estimates for waste processing alternatives/options presented in this report include facility closure, deactivation, and decommissioning costs for facilities that are not yet built but are needed for the alternative. Closure estimates for proposed facilities assume that those facilities would be closed to meet Clean Closure requirements. Those estimated costs are not restated in the facility disposition sections of this report.

Only existing HLW facilities not expected to be used in any waste processing alternative are considered in this section. The manner of closure of an existing facility can result in a dramatically different cost. The three primary types of closure are Clean Closure, Performance-Based Closure, and Closure to Landfill Standards. Of the three closure methods, Clean Closure would require the most effort because more contamination would need to be removed so that the level of remaining contamination would approximate background conditions for the presence of radioactive and hazardous materials. The Idaho HLW & FD EIS analyzes most of the existing facilities in the Closure to Landfill Standards Alternative.

Major facilities were analyzed for two or more closure methods to compare the costs. These include the Tank Farm, bin sets, Process Equipment Waste Evaporator and related facilities, Fuel Processing Building and related facilities, and New Waste Calcining Facility. The cost of Clean Closure was not estimated for some facilities because the levels of contamination are very high, worker health risk would be much higher than is usually accepted, and costs would be very great. Closure to Landfill Standards can drastically reduce closure costs and limit worker and public health risks to acceptable levels.

3.2.2 CLOSURE METHODS

Clean Closure – Facilities would have hazardous wastes and radiological contaminants, including contaminated equipment, removed from the site or treated so that the hazardous and radiological contaminants are below detection or indistinguishable from background concentrations. Clean Closure may require total dismantling and removal of facilities. Use of the facilities (or the facility sites) after Clean Closure would present no risk to workers or the public from hazardous or radiological components.

Performance-Based Closure – Closure methods would be dictated on a case-by-case basis depending on risk. For radiological and chemical hazards, Performance-Based Closure would be performed in accordance with risk-based criteria. The facilities would be decontaminated so that residual waste and contaminants no longer pose any unacceptable exposure (or risk) to workers or to the public. Post-closure monitoring may be required on a case-by-case basis.

Closure to Landfill Standards – The facility would be closed in accordance with the state and Federal requirements for closure of landfills. Waste residuals would be stabilized to minimize the release of contaminants into the environment. Closure to landfill standards is intended to protect the health and safety of the workers and the public from releases of contaminants from the facility. This result could be achieved by installing an engineered cap, establishing a groundwater monitoring system, and providing post-closure monitoring and care of the waste containment system, depending on the type of contaminants.

In order to accommodate the use of the Tank Farm and bin sets for disposal of LLW, the Idaho HLW & FD EIS also evaluates two additional facility disposition alternatives for the Tank Farm and bin sets. Several of the waste processing alternatives result in production of a LLW fraction, which would then be grouted and disposed either in (1) a near-surface disposal facility on the INEEL, (2) the Tank Farm and bin sets, or (3) a licensed offsite disposal facility. Disposition of LLW in the Tank Farms and bin sets (i.e., disposal of Class A or Class C type grout) would occur after these facilities have been closed under the Performance-Based Closure Alternative.

Performance-Based Closure with Class A Grout Disposal – The facilities would be closed as described above for Performance-Based Closure. Following completion of those activities, the Tank Farm and bin sets would be used to dispose of LLW Class A type grout produced under the Full Separations Option.

Performance-Based Closure with Class C Grout Disposal – The facilities would be closed as described above for Performance-Based Closure. Following completion of those activities, the Tank Farm and bin sets would be used to dispose of LLW Class C type grout produced under the Transuranic Separations Option.

3.3 Relationship to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)

DOE has completed a comprehensive evaluation for the cleanup program for INTEC (known as Waste Area Group 3) under the requirements of CERCLA. Under the CERCLA program, DOE, the U.S. Environmental Protection Agency (EPA), and the State of Idaho have made decisions regarding disposition of environmental media such as contaminated soils and water. DOE will continue to make CERCLA program decisions regarding the final state of INTEC after all cleanup and facility closure activities have been completed. While the CERCLA program is not the subject of the Idaho HLW & FD

EIS, decisions regarding disposition of HLW facilities are being coordinated with decisions made in the CERCLA program. DOE has prepared a proposed plan for the CERCLA actions and issued a CERCLA Record of Decision in October 1999 (DOE 1999b).

4.0 COST ANALYSIS ASSUMPTIONS AND BASES

4.1 Waste Processing Assumptions and Bases

DOE used several assumptions and bases to prepare the Idaho HLW & FD EIS and develop the cost estimates, which include costs for product waste packaging, transportation, product waste disposal, and long-term storage of wastes. Many of the assumptions and bases are specific to a particular project rather than all of the alternatives or options. Assumptions were developed for each project cost estimate and were specific to the functions of each project. The assumptions and bases included such items as the size of buildings, capacity of waste handling, materials to be used in construction, relationship to other projects, and approximate schedule. These assumptions are included in the cost estimate packages.

General Assumptions and Bases

- Estimates were calculated in 1998 non-discounted dollars (except for discounted cash flow analysis).
- Technologically, all waste processing alternatives could be deployed and operated as intended. All of the alternatives except No Action would require additional technology development.
- Activities for all projects were assumed to be completed by the year 2095 with milestones as noted in Figures 2 through 9.
- Costs for CERCLA cleanup activities at INTEC were not included in the estimates (see Section 3.3). Facility disposition costs for RCRA closures of HLW facilities within INTEC are included.

Assumptions and Bases Specific to Product Waste Packaging

Common assumptions about the number and type of containers were used to define the amount of product waste to compare across the various alternatives and options.

- The treated HLW produced at INEEL would be packaged in stainless steel canisters similar to those used at the Savannah River Site (SRS) Defense Waste Processing Facility (2 feet in diameter by 10 feet long).

- The treated LLW fraction produced at INEEL would be packaged in concrete cylindrical containers with a capacity of about 1 cubic meter.

- Remote-handled (RH) TRU waste would be packaged in Waste Isolation Pilot Plant (WIPP) half-containers with a capacity of 0.4 cubic meter.

- Contact-handled (CH) TRU waste would be packaged in 55-gallon drums.

- The treated HLW produced at the Hanford Site would be packaged in stainless steel canisters (2 feet in diameter by 15 feet long) similar to those proposed for use by TWRS.

- The treated LLW fraction produced at the Hanford Site would be packaged in stainless steel boxes (4 feet by 4 feet by 6 feet) with a capacity of about 2.6 cubic meters, similar to those proposed for use by TWRS.

Assumptions and Bases Specific to Transportation

The following assumptions apply to shipments of waste to or from the INEEL.

- A rail shipment of HLW to a repository would consist of four rail cars each carrying one cask of five HLW canisters (total of 20 canisters per rail shipment).

- A truck shipment of HLW to a repository would consist of a single cask containing one HLW canister.

- RH TRU waste would be transported to WIPP using the RH-72B cask; one cask would be transported per truck shipment; and two casks would be transported per rail shipment. Each cask would contain two RH TRU waste half-containers.

- CH TRU waste would be transported to WIPP using TRUPACT-II containers (see Appendix A, Glossary). Three TRUPACT-IIs would be used for each truck shipment, and six TRUPACT-IIs would be used per rail shipment. Each TRUPACT-II would contain nine 55-gallon drums.

- A truck shipment of Class A type grout would include six INEEL LLW containers. A rail shipment would include 20 INEEL LLW containers.

- A truck shipment of Class C type grout would include three INEEL LLW containers. A rail shipment would include 10 INEEL LLW containers.

- A truck shipment of vitrified LLW would include nine TWRS LLW containers. A rail shipment would include 18 TWRS LLW containers.

<u>Assumptions and Bases Specific to Waste Management</u>

Newly generated liquid mixed transuranic waste that is managed independent of the proposed waste processing method for the HLW calcine and liquid mixed transuranic waste/SBW is evaluated as process waste. This action occurs under the alternatives and options that would continue to operate the calciner after June 2000 (Continued Current Operations Alternative, Planning Basis Option, Hot Isostatic Pressed Waste Option, and Direct Cement Waste Option). The grouted mixed transuranic waste (newly generated liquid waste) would be managed in the same manner as other low-level process waste [i.e., assumed disposal at the Radioactive Waste Management Complex or an alternate disposal location to be determined based on the *Waste Management Programmatic EIS* Record of Decision (WM PEIS ROD)]. In those alternatives where newly generated liquid mixed transuranic waste is managed along with the existing liquid mixed transuranic waste/SBW, product waste volumes would increase slightly as noted in Section 5.2.13 of the Idaho HLW & FD EIS.

<u>Assumptions and Bases Specific to Offsite Product Waste Disposal</u>

A number of project-level assumptions were made about the potential offsite disposal location for the various product wastes:

- Treated HLW would be shipped to the proposed repository at Yucca Mountain in Nevada after the wastes have been delisted from RCRA requirements.
- TRU waste would be shipped to WIPP near Carlsbad, New Mexico.
- LLW Class A type grout and vitrified LLW would be shipped to the commercial radioactive waste disposal facility operated by Envirocare, near Salt Lake City, Utah.
- LLW Class C type grout would be shipped to the commercial radioactive waste disposal facility operated by Chem-Nuclear Services near Barnwell, South Carolina.

These locations provided the basis for evaluating transportation-related impacts of offsite disposal activities but do not predetermine the selection of ultimate disposal locations. Potential onsite disposal locations (Tank Farm and bin sets, new disposal facility near INTEC) were also evaluated for the LLW fractions.

Assumptions and Bases Specific to Long-Term Storage of Untreated HLW and Mixed Transuranic Waste/SBW and Interim Storage of Treated HLW

- Under the No Action Alternative, liquid mixed transuranic waste/SBW and mixed HLW calcine would remain stored in the Tank Farm and bin sets through 2095. Storage impacts would be fairly constant from year to year during this period of active institutional controls.

- Under the Continued Current Operations Alternative, calcined HLW and mixed transuranic waste/ SBW would remain in bin set storage through 2095.

- For those alternatives and options that result in treatment of HLW to a road-ready condition (Full Separations Option, Planning Basis Option, Non-Separations Alternative, and Minimum INEEL Processing Alternative), the treated waste would be placed in a RCRA-compliant interim storage facility at INTEC.

4.2 Facility Disposition Assumptions and Bases

Assumptions and bases specific to the facility disposition estimates are listed below:

- Estimates address only post-operational activities for existing facilities because the facilities are no longer needed.

- Facilities are assumed to be in a condition similar to the current conditions when facility disposition would begin.

- Closure, deactivation, or decommissioning would be conducted to meet present day applicable RCRA standards if hazardous materials are known to be present at the facility.

- Closnre, deactivation, or decommissioning would be conducted to meet applicable DOE orders.

Cleanup of contaminated soils and groundwater is generally not included in the estimates because CERCLA cleanup of contaminated soils is being planned and performed according to the Federal Facility Agreement and Consent Order as explained in Section 3.2 of the Idaho HLW & FD EIS.

5.0 METHODOLOGY

Lockheed Martin Idaho Technologies Company (LMITCO) and Tetra Tech NUS (TtNUS), contractors for DOE, prepared cost estimates for the projects. LMITCO prepared estimates for facilities that would be constructed at INEEL. TtNUS prepared estimates for the projects and actions that would be conducted away from INEEL. These include transportation; treatment at Hanford; storage at Hanford; and disposal at a repository, WIPP, and at offsite low-level waste disposal facilities, depending on the waste form.

5.1 Waste Processing Cost Methodology

Because of the nature of the projects, two general types of cost estimating approaches are used:

- Detailed "bottoms-up estimates" based on conceptual design data for engineering projects. These are the types of estimates prepared by LMITCO.

- Scaling of costs or specific analogy estimates based on derived unit rates for transportation and disposal projects that are similar to the projects in the Idaho HLW & FD EIS. These are the types of estimates prepared by TtNUS.

The bottoms-up cost estimating methodology used by LMITCO consisted of the following approach. Standard LMITCO multipliers for general and administrative costs and profit were applied in the bottoms-up estimates. The basic assumptions listed below were established for various elements of alternatives and options, also referred to as projects:

> **Bottoms-up Estimating**
> A cost estimating technique that employs a statement of work and set of drawings or specifications to calculate resources to complete a project. Direct labor, equipment, and overhead costs are derived from the information.

- Estimates were calculated in 1998 non-discounted dollars (except for discounted cash flow analysis).

- Technologies in the alternatives could be deployed and operated as intended.

- Costs for CERCLA cleanup activities at INTEC were not included. Facility disposition costs for RCRA closures of HLW facilities within INTEC are included.

The timeframe, schedule, and other project parameters were developed. Standard cost estimating procedures were followed as stated in the *INEEL Cost Estimating Guide* (LMITCO 1998). Other aspects of the estimates were developed by using drawings, design reports, engineer's notes, and documentation provided by a project manager. For comparable work, prior estimates or costs were scaled appropriately and used for the individual components of the projects. These costs were rolled up into the project's total estimated cost (TEC) and other project costs (OPC) and LCCs for operating and maintaining the project were estimated. In some instances, consulting engineers were used to develop estimates for project components.

Transportation-related impacts for offsite waste shipments were evaluated in various EISs. DOE did not analyze environmental impacts for offsite disposal of waste at a repository, WIPP, and offsite LLW disposal facilities in the Idaho HLW & FD EIS as discussed in the *Process for Identifying Potential Alternatives Report* (DOE 1998a). However, as described in Section 5.2, this report includes costs for offsite disposal to represent DOE complex-wide costs.

In some cases, the cost source data was stated in the reference in 1996 dollars or dollars from some other year because that was the latest available information. In those cases, cost data were restated in 1998 dollars using the OMB Circular A-94 annual escalation rate of 3 percent that was applicable for that period.

The cost-estimating process consisted of several steps as illustrated in Figure 10. The first step was to prepare the TEC for each project. The TEC was prepared at the planning level (or range of magnitude) using a bottoms-up technique. Another estimate known as OPC was also developed for each project. The sum of the TEC and OPC is the Total Project Cost (TPC).

Total Estimated Cost
(Capital Cost)
TECs include engineering design costs (after conceptual design), facility construction costs, and other costs specifically related to those construction efforts.

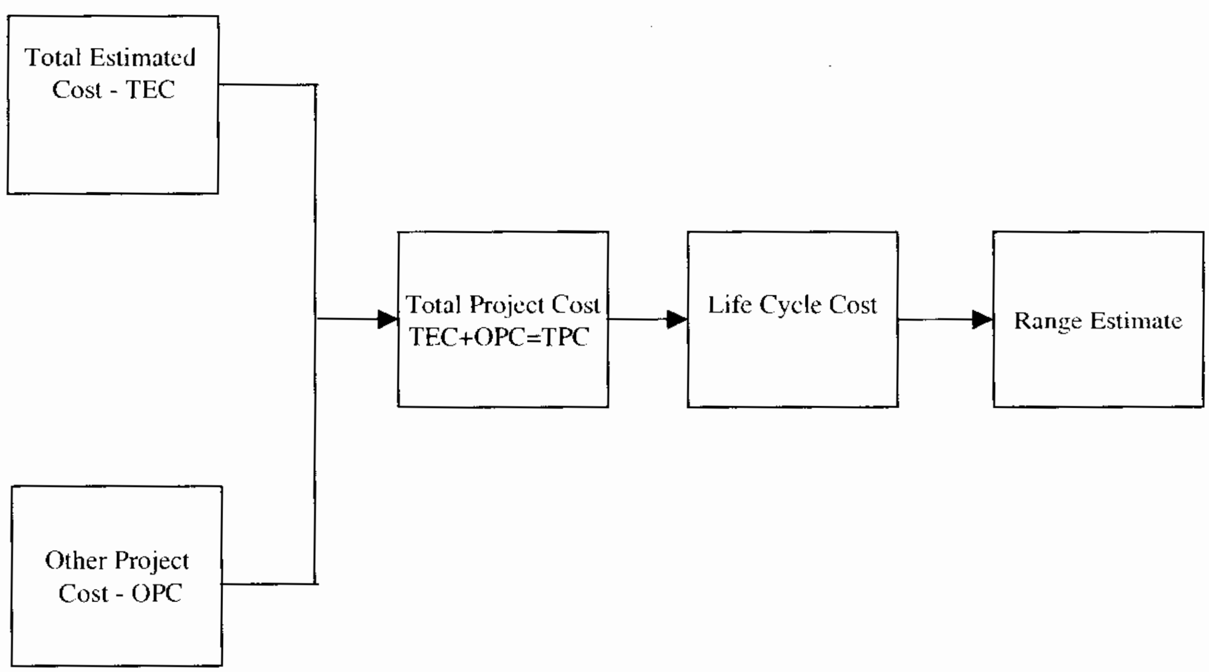


Figure 10. Engineering project cost estimating process.

The next step was preparation of LCCs for each project. Several project stages are included in the cost estimates such as treatment (waste processing), interim storage, transportation, and disposal. The LCC of a project takes into consideration the time value of money by escalating costs so that a TPC is adjusted for expected inflation between 1998 and the time when the project expenditures would occur.

Other Project Costs

OPCs are all other costs related to a project that are not included in the TEC. OPCs include such items as research aud development, National Environmental Policy Act documentation, and project data sheets.

5.2 Transportation and Disposal Project Cost Methodology

5.2.1 TRANSPORTATION

Product and process waste volumes were derived from project data sheets in Appendix C.6 of the Idaho HLW & FD EIS. These project data sheets were used to calculate the project costs by multiplying the volume (or number of containers) by the unit cost to give initial single point estimates for the transportation projects. High and low ranges of costs were developed for the projects based on unit costs (Peel 1999a).

The primary sources of transportation unit costs are:

- *DOE Waste Management Final PEIS* (DOE 1996)
- *Waste Isolation Pilot Plant Disposal Phase Final Supplemental Environmental Impact Statement* (DOE 1997a)
- *Waste Management Facilities Cost Information for Transportation and Hazardous Materials* (Feizollahi, Shropshire, and Burton 1995)

The following example illustrates the way transportation estimated costs were scaled from other program data. Shipments of LLW Class A type grout and vitrified LLW from INEEL to the Envirocare disposal facility were assumed for several waste processing options. Unit costs from a DOE planning reference (Feizollahi, Shropshire, and Burton 1995) used in the *Waste Management Final PEIS* were used as a basis to derive costs for truck transportation of low-level waste at $4.00 per mile with 4,200 truck shipments. Highway mileage between the INEEL and Envirocare is 299 miles. Thus, the estimated cost for truck transportation is the example is:

$\$4.00 \times 4{,}200 \times 299 = \$4{,}018{,}604$

A cost range of plus or minus 20 percent was applied. This range was considered appropriate because transporting low-level waste is a common activity that would employ proven technology. The primary potential for cost variation would be due to changes in the number of shipments (driven by waste volume). Accuracy in the estimate of shipments is expected to improve as the project design progresses from the current early planning stage.

5.2.2 DISPOSAL

Unit costs from other relevant DOE or commercial projects form the basis for unit costs applied to the Idaho HLW & FD EIS. For example, HLW disposal is assumed to take place at the proposed Yucca Mountain HLW repository. DOE has not selected Yucca Mountain as the repository site for HLW disposal; however, Yucca Mountain is the only site being characterized by DOE for a repository.

Repository costs (see Appendix F) are very preliminary due to the early stage of development of a repository for HLW, yet the disposal costs are a very important discriminator in the overall cost of the Idaho HLW & FD EIS alternatives and options. The DOE Office of Civilian Radioactive Waste Management (OCRWM) has recently prepared a total-system LCC report for the proposed repository at Yucca Mountain (DOE 1998b). This report is the basis of the HLW repository costs for several of the alternatives and options. Rather than duplicate the efforts of OCRWM with another bottoms-up cost estimate, the Idaho HLW & FD EIS makes use of estimates taken from the OCRWM LCC document and other relevant and reliable studies and scales them to match the quantities applicable to the EIS.

Disposal costs were developed using the same process as described above for the transportation projects. Disposal costs are based on:

- *Analysis of the Total System Life-Cycle Cost of the Civilian Radioactive Waste Management Program* (DOE 1998b)
- *INEEL High-Level Waste Program Impacts Related to Disposal Fees and Ability of Repository to Accept Waste* (Stegan 1997a)
- *Waste Isolation Pilot Plant Disposal Phase Supplemental Environmental Impact Statement* (DOE 1997a)
- *Commercial LLW Disposal Cost Data* (DOE 1998c)

- *Report on the Office of Environmental Restoration Waste Disposal Cost Workshop* (Jacobs 1997)
- "*National Geologic Repository Cost Estimate Calculation*" (Peel 1999b)

DOE considers the sources of cost data to be sufficiently current for the analysis. The data have been used as a cost basis for other DOE programs. The data were used consistently to analyze the alternatives and options to ensure that the cost estimates are comparable.

5.3 Life Cycle Cost Methodology

LCCs were prepared for each alternative and option to identify the likely annual cost, the cumulative cost over time, and present value of cash flow needed to implement the alternative or option. Costs were generated in three phases (construction, operations, and post operations). All costs were escalated at 2.8 percent (2.4 percent for 1999) and discounted by 6.1 percent per OMB Circular A-94 (OMB 1992) and DOE guidance (DOE 1997b). The LCC also considers funding associated with any alternative or option subject to annual funding requests and commitment of funds (see Section 6.1.2 for additional explanation of annual funding). Offsite projects such as transportation and disposal required a modified approach due to available information and were not incorporated in the LCC prepared by LMITCO but were added for development of the probabilistic cost estimates.

> **Life Cycle Cost**
> LCCs are all the anticipated costs associated with a project or program throughout its life, including direct and indirect initial costs plus any periodic or continuing costs of operation and maintenance and facility disposition.

5.4 Facility Disposition Cost Methodology

Facility disposition estimates were prepared for existing facilities that are no longer needed. The facility disposition estimates for the proposed projects are based on the "engineered for closure" concept. In contrast, the existing facilities that are no longer needed were not designed with closure in mind and in general are more complicated and costly to close.

> **Parametric Model**
> Parametric estimating requires historical data based on similar systems or subsystems. Statistical analysis is performed on the data to determine correlation between cost drivers and other system parameters such as design or performance parameters. The analysis produces cost equations or cost estimating relationships that can be used individually or grouped into more complex models.

The basis for the Idaho HLW & FD EIS facility disposition cost estimates is a decontamination and decommissioning (D&D) cost model spreadsheet prepared by an INEEL management and operating contractor. That model was based on previous EM-60 Demolition Projects to obtain cost per square foot as the basis for D&D of the facilities. The model was prepared using 1994/1995 costs. These costs were escalated in the model to 1998 dollars for this project. A flow diagram that illustrates the model components is shown in Figure 11.

Inputs required by the model include: facility size in square feet, the type of facility construction (i.e., concrete, steel, wood, etc.), the degree of asbestos abatement anticipated in the facility, the degree of radiological contamination in the facility, the degree of RCRA hazardous material contamination in the facility, the number of operational systems within the facility, and the percentage of the facility located underground. The model assigns costs or factors based on these inputs. These costs and factors were developed from actual historical costs at INEEL, cost data handbooks, and engineering experience. For this project, the spreadsheet was expanded to include cost adjustments for the closure method. These adjustment inputs were based on parametric modeling and engineering experience. Based on all the above inputs, an estimate was derived for D&D costs.

Characterization costs are based on the D&D cost. Depending on the anticipated characterization of asbestos, radiological, or hazardous contamination effort, the cost ranges from 20 to 30 percent of the D&D cost. Deactivation cost is estimated at 10 percent of the sum of the D&D cost and characterization cost. Again, these factors are based on historical data at the INEEL.

The facility disposition estimates that were prepared are range of magnitude (ROM) estimates. As such, the estimates are based on preliminary data that are likely to change as the projects become better defined.

Range of Magnitude (Planning Estimate)

A type of estimate developed in the earliest stage of the budget cycle and project formulation for each project under consideration. ROM costs are developed soon after potential projects are identified but before conceptual design occurs and are based on such things as a description of the project's purpose, general design criteria, significant features and components, proposed methods of accomplishment, proposed construction schedule, research and development requirements, and technical functional requirements.

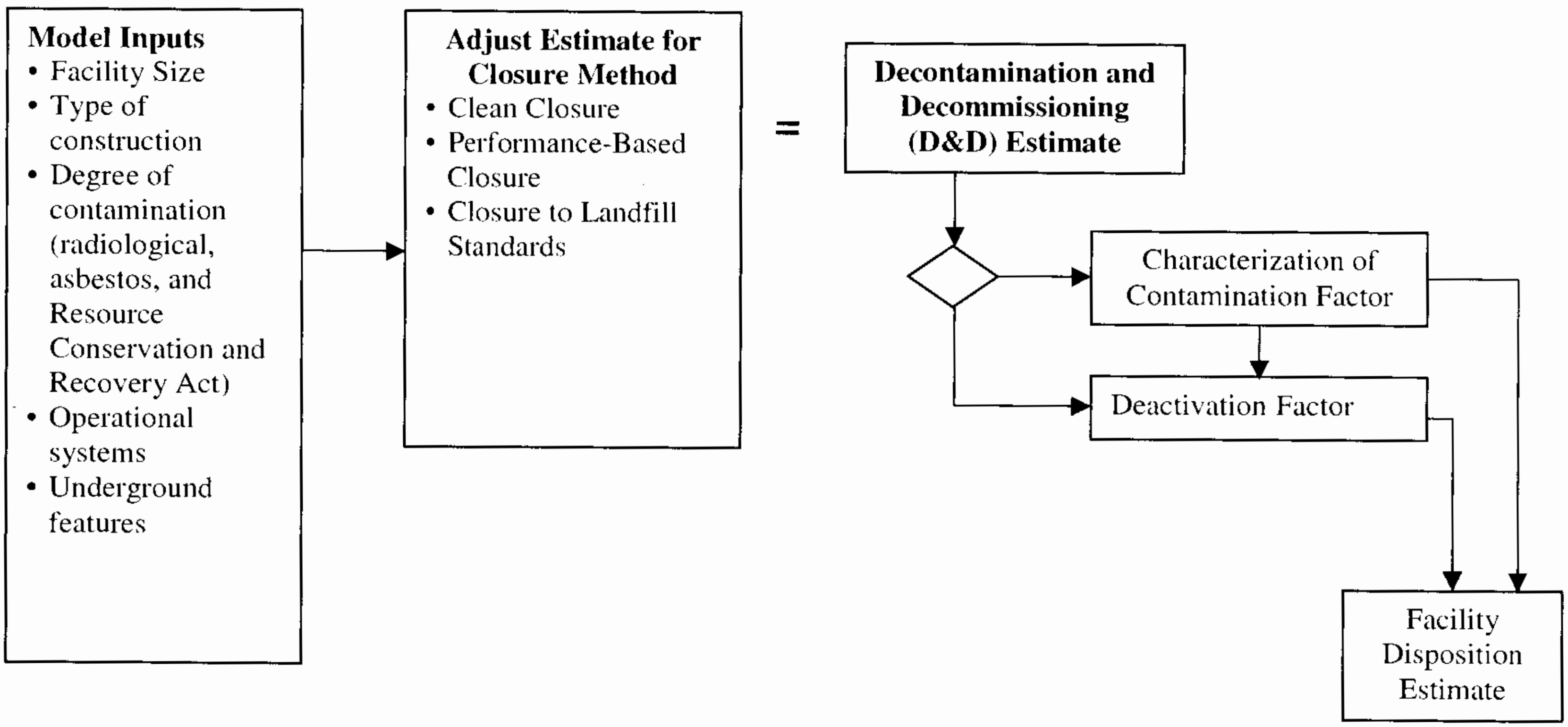
5.5 Probabilistic Cost Estimating Methodology

Because future events are uncertain, probabilistic cost estimates were prepared to establish an upper and lower range of estimated costs for the alternatives or options. The probabilistic cost estimates are also known as range estimates. Range estimates were developed using two software programs: Range Estimating Program for PC (REP/PC) and Crystal Ball®. Both programs use the Monte Carlo technique to simulate a range of possible cost results using probability theory. The inputs to the simulations consisted of low, high, and target costs for project

Range Estimate

A cost estimate that is based on the probability of a project to be completed (construction and/or operation) within a stated range of values. The results of a range estimate are a target cost, high cost, and low cost. The HLW program used 95 percent and 10 percent for the high and low range. The high value is assumed to be a 95 percent chance that the completed project (as built) would be at or below the value.

Figure 11
Facility Disposition Cost Estimating Process



components. A group of technical specialists and engineers familiar with the proposed projects reviewed the LCC estimates and used professional judgement to adjust the estimates for input into REP/PC. This program considers such project factors as the level of uncertainty, the maturity of the technology, the stage of the project, and other cost-related risks. Output from the model gives a better appreciation of the cost risk of the estimate than is obtained from a single point estimate by determining a range of predicted costs through a Monte Carlo simulation. LMITCO used REP/PC to generate range estimates for most of the waste treatment, storage, and onsite disposal projects.

The Crystal Ball® software package was used to combine the cost estimate and uncertainty data from each project to calculate probabilistically derived range estimates for each of the waste processing alternatives and options (DMA 1999). Outputs from the simulations (Appendix D) consisted of:

- The expected total cost for each alternative and option
- The theoretical minimum and maximum expected total cost for each alternative and option
- Percentile data regarding the expected total cost for each alternative and option (i.e., the chance of an alternative to exceed an estimated cost)
- Frequency distribution charts showing the results of 2,000 simulation trials for each alternative and option
- Summary charts that compare the range estimates and cost components for the waste processing alternatives

Probability Theory

This theory is the branch of mathematics that develops models for "chance variations" or "random phenomena." It originated as a rigorous discipline when mathematicians of the 17th century began calculating the odds in various games of chance. It was applied to the study of errors in experimental measurements and to the study of human mortality (for example, by life insurance companies). Probability theory is a major branch of mathematics with widespread applications in science and engineering. Probability theory has been applied to cost estimating to ascertain the likelihood that a cost estimate would be completed within the estimated cost.

6.0 RESULTS

6.1 Estimated Cost of Waste Processing Alternatives

The estimated cost of the waste processing alternatives and options ranges from $717 million for the No Action Alternative to $15.2 billion for Direct Cement Waste Option. These are target costs developed by the cost estimating team using standard contingency amounts for probabilities or uncertainties addressed elsewhere in this report. Table 5 and Figure 12 compare the estimated costs.

Table 5. Cost of waste processing alternatives.

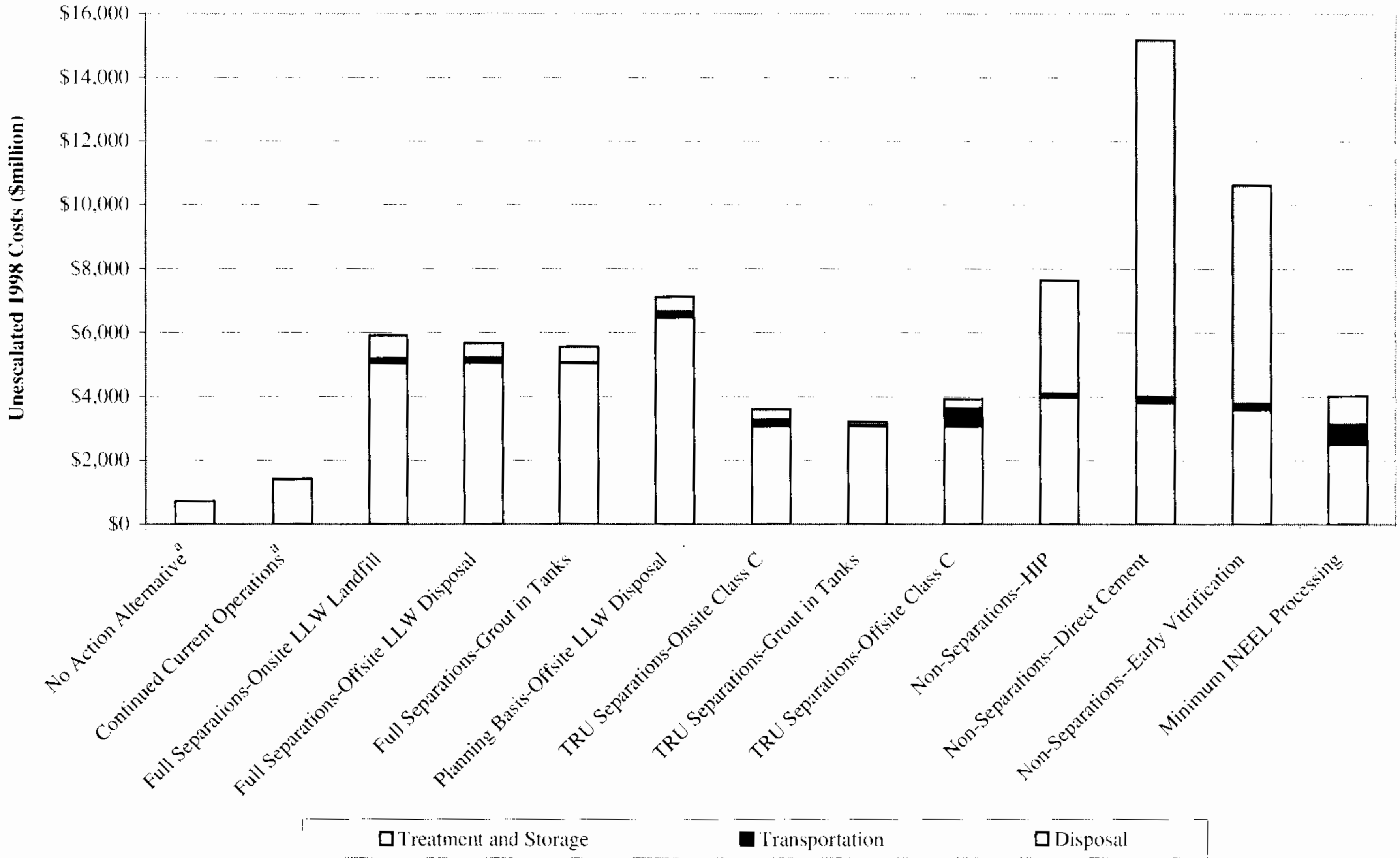
Alternative	Unescalated 1998 costs ($ millions)			
	Treatment and Storage	Transportation	Disposal	Total
No Action Alternative	$717	$0	$0	$717
Continued Current Operations Alternative	$1,406	$2	$21	$1,429
Separations Alternative				
Full Separations Option				
Onsite LLW Class A Type Grout Disposal	$5,045	$162	$716	$5,924
Offsite LLW Class A Type Grout Disposal	$5,045	$176	$447	$5,668
Grout in Tanks	$5,045	$35	$485	$5,566
Planning Basis Option	$6,475	$179	$469	$7,123
Transuranic Separations Option				
Onsite LLW Class C Type Grout Disposal	$3,072	$211	$322	$3,606
Grout in Tanks	$3,072	$47	$100	$3,219
Offsite LLW Class C Type Grout Disposal	$3,072	$560	$292	$3,924
Non-Separations Alternative				
Hot Isostatic Pressed Waste Option	$3,975	$115	$3,546	$7,637
Direct Cement Waste Option	$3,816	$182	$11,181	$15,178
Early Vitrification Option	$3,593	$203	$6,810	$10,606
Minimum INEEL Processing Alternative[a]	$2,501	$637	$891	$4,028

a. The Minimum INEEL Processing Alternative values represent the Interim Storage Shipping Scenario with INEEL disposal of the vitrified LLW fraction. The expected costs ($millions) for the other three scenarios for the Minimum INEEL Processing Alternative are:

Interim Storage Shipping Scenario (Offsite facility disposal option)	$3,511
Just-In-Time Shipping Scenario (New INEEL disposal of vitrified LLW fraction)	$3,589
Just-In-Time Shipping Scenario (Offsite facility disposal option)	$3,072

The major components of the cost estimates, treatment, transportation and storage, and disposal are also shown in Figure 12. As Figure 12 illustrates, treatment and disposal represent the largest percentage of the costs for each alternative. Alternatives that would produce a large number of HLW canisters such as the Direct Cement Waste Option, Hot Isostatic Pressed Waste Option, and Early Vitrification Option would incur very large disposal costs assuming disposal at the proposed Yucca Mountain repository. Transportation costs are relatively small compared with the total cost of each alternative. The two exceptions are the Minimum INEEL Processing Alternative and the Transuranic Separations Option-Offsite Class C Grout Disposal where 14 to 16 percent of the costs are for transportation because of the travel distances and number of shipments to offsite facilities.

Figure 12
Waste Processing Alternatives by Cost Component



a. These alternatives do not take the HLW program to an end state.

6.1.1 PROBABILISTIC COST ESTIMATE RESULTS

The costs for each waste processing alternative and option are presented in this section. The Transuranic Separations Option with Tank Farm, Bin Set Grout Disposal (Grout in Tanks) has the lowest cost of the alternatives and options that would produce waste forms that could be accepted for disposal at current or planned disposal facilities. All of the Non-Separations Alternative options would cost more than any of the Separations Alternative or Minimum INEEL Processing Alternative options. The Direct Cement Waste Option would cost approximately four times more than the Transuranic Separations Option with onsite LLW Class C type grout disposal in the Tank Farms and bin sets.

Results of the probabilistic cost estimating process are shown in Table 6 in unescalated 1998 dollars. Figure 13 and Table 6 present the range of estimated costs for each option. These include the expected costs and the low and high costs based on the uncertainty factors (see Section 7.0).

The cost estimates indicate that the No Action Alternative and Continued Current Operations Alternative are the least expensive of the alternatives and options at $0.72 billion and $1.4 billion, respectively. However, these alternatives would not produce waste forms that would be suitable for permanent disposal. The waste would be primarily in the form of granular calcine that currently does not meet the anticipated waste acceptance criteria for the proposed Yucca Mountain repository.

Four options are somewhat more expensive; however, they would produce waste forms that could meet waste acceptance criteria at disposal facilities:

- Transuranic Separations – Tank Farm, Bin Set Grout Disposal — $3.2 billion
- Transuranic Separations – New INEEL Disposal of LLW Class C Type Grout — $3.6 billion
- Transuranic Separations – Offsite LLW Class C Type Grout Disposal — $3.9 billion
- Minimum INEEL Processing Alternative Interim Storage Shipping Scenario (disposal of vitrified LLW in a new INEEL landfill) — $4.0 billion

The Direct Cement Waste Option costs more than any other option at $15.2 billion. Other options are within a range of $5.6 billion to $10.6 billion. The three Non-Separations Alternative options, ranging between $7.6 billion and $15.2 billion, cost more than the Separations Alternative.

6.1.2 ANNUAL FUNDING ANALYSIS

Costs of the alternatives and options were calculated to evaluate the timing of the activities, discounted cash flow (time value of money), and annual funding requirements.

Figure 13
Waste Processing Alternative Cost Estimate Ranges

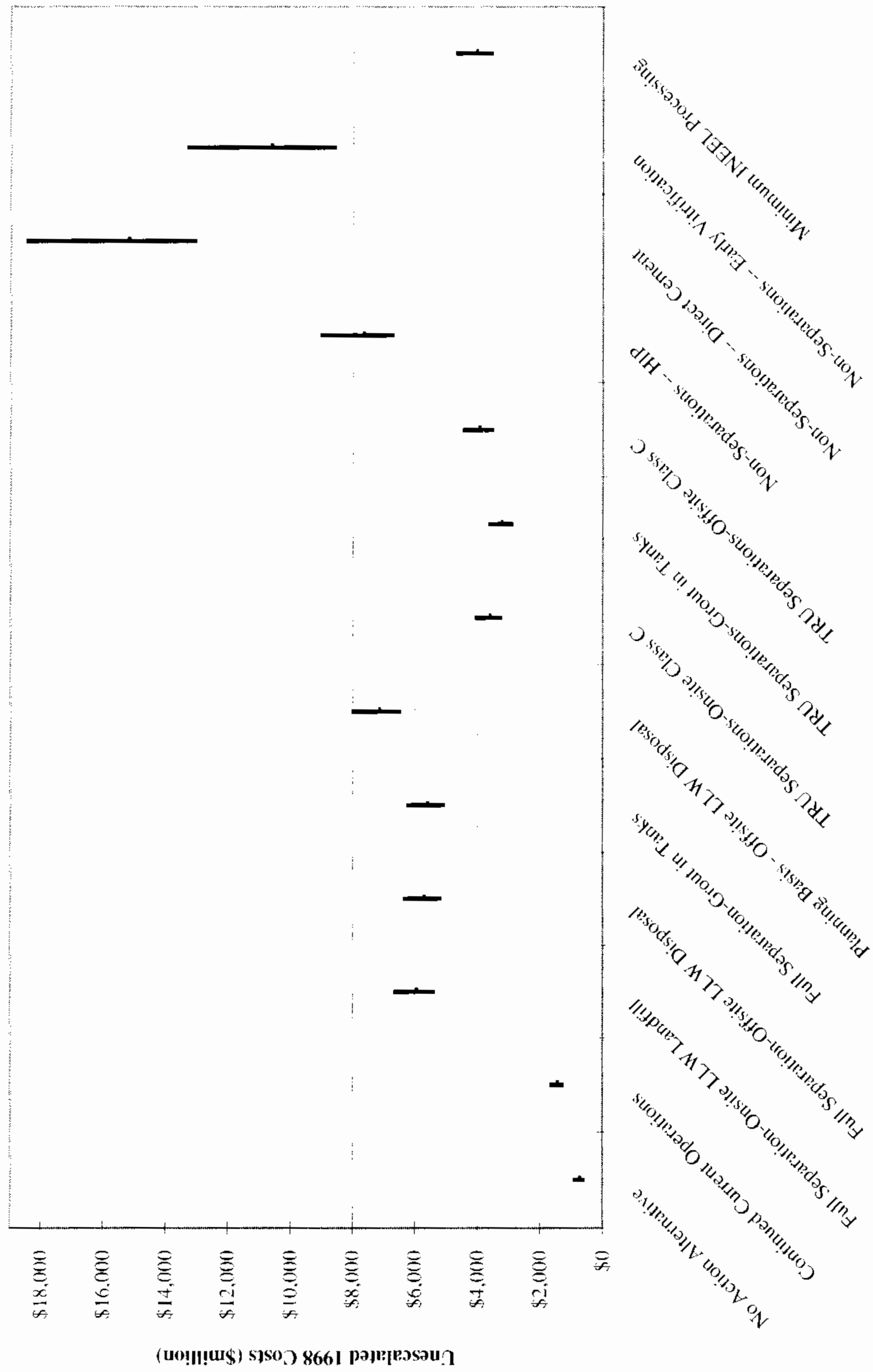


Table 6. Range of waste processing alternative costs.

Alternative/Option	Unescalated 1998 costs ($ millions)		
	High range[a]	Low range[b]	Expected cost
No Action Alternative	$859	$621	$717
Continued Current Operations Alternative	$1,617	$1,295	$1,429
Separations Alternative			
Full Separations Option			
Onsite LLW Class A Type Grout Disposal	$6,599	$5,422	$5,924
Offsite LLW Class A Type Grout Disposal	$6,305	$5,194	$5,668
Grout in Tanks	$6,192	$5,099	$5,566
Planning Basis Option	$7,971	$6,507	$7,123
Transuranic Separations Option			
Onsite LLW Class C Type Grout Disposal	$4,027	$3,288	$3,606
Grout in Tanks	$3,587	$2,940	$3,219
Offsite LLW Class C Type Grout Disposal	$4,421	$3,553	$3,924
Non-Separations Alternative			
Hot Isostatic Pressed Waste Option	$8,984	$6,736	$7,637
Direct Cement Waste Option	$18,429	$13,079	$15,178
Early Vitrification Option	$13,264	$8,615	$10,606
Minimum INEEL Processing Alternative	$4,642	$3,600	$4,028

a. There is a 95 percent chance that the cost of the completed alternative would be less than or equal to this value.
b. There is a 10 percent chance that the cost of the completed alternative would be less than or equal to this value.

Figure 14 illustrates a comparison of the current annual funding (in unescalated 1998 dollars) for the INEEL HLW program. The LCCs were divided into 5-year segments for analysis of average and peak funding requirements for the waste processing alternatives and options. The current annual funding level for DOE is expected to remain the same under the current planning assumptions through the year 2007 (DOE 1998d). The only alternative that could be implemented at the FY1999 level of funding is the No Action Alternative. Other alternatives or options would require 2 to 11 times the current funding levels to be adequately funded to meet current regulatory requirements. Appendix B provides additional information and an example for LCCs. Appendix E presents more details for the annual funding analysis.

Figure 15 presents the peak annual funding needs based on 5-year segments for each alternative and option. Peak annual funding is important because Federal program funding is commonly based on approximately level funding with limited flexibility to accommodate large peaks in the funding profile. Escalation and discount rates were used from guidance based on OMB Circular A-94 (OMB 1992).

Figure 14
Peak Annual Funding Requirements by Alternative
(based on five-year increments)

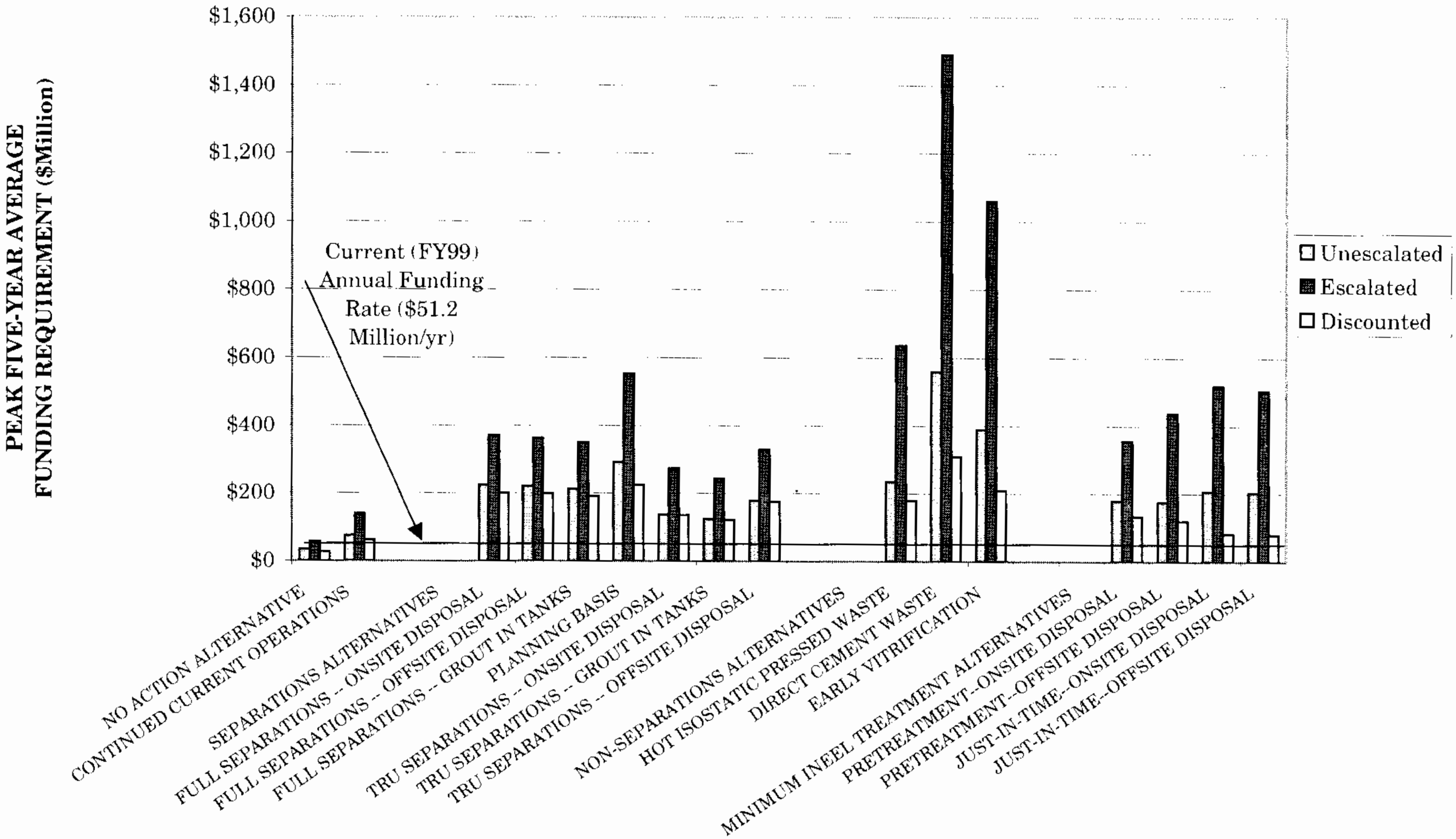
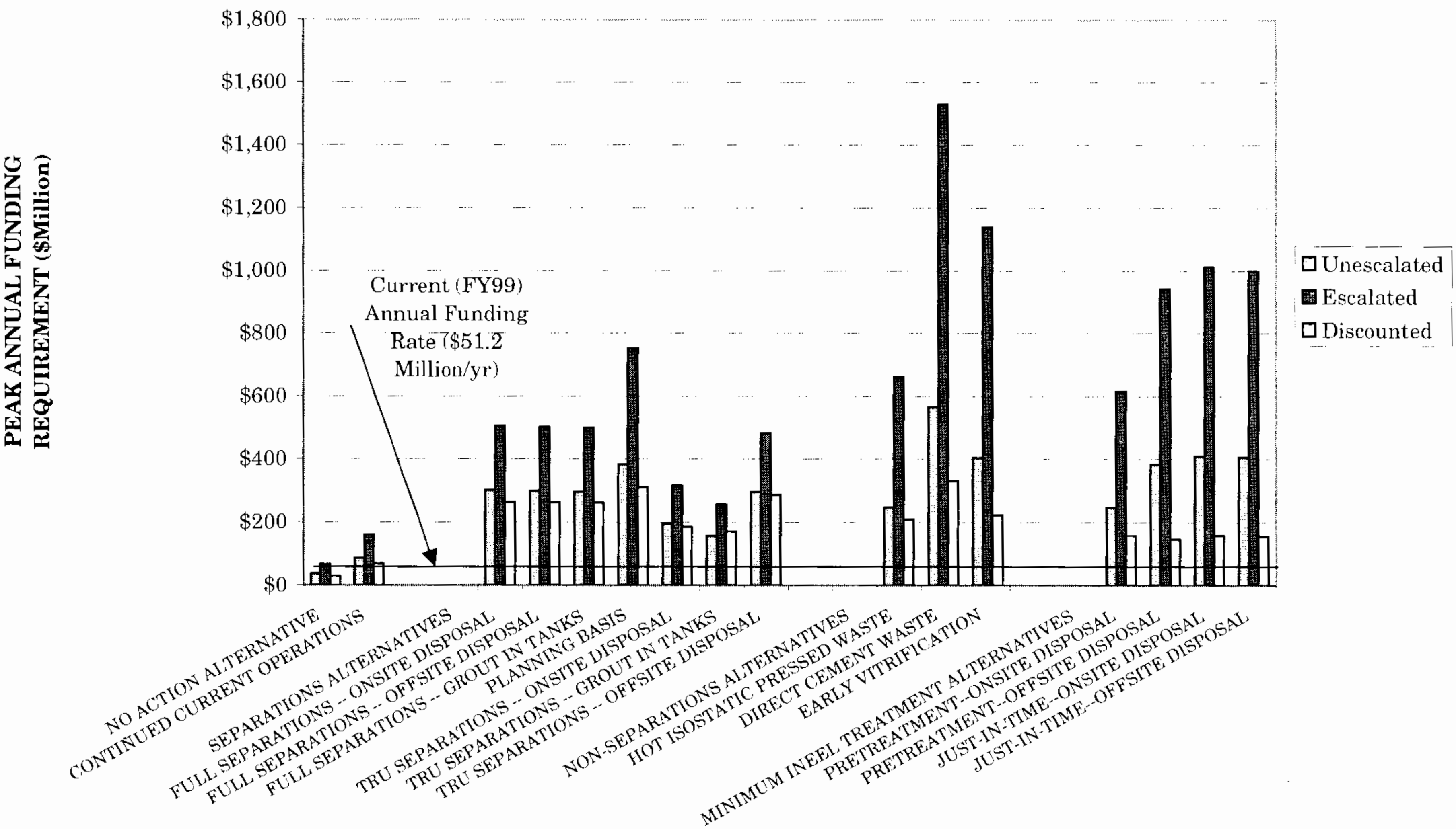


Figure 15
Peak Annual Funding Requirements by Alternative



6.2 Facility Disposition Results

For the Tank Farm and bin sets, which together constitute the majority of the total inventory of residual radioactivity, DOE analyzed all the facility disposition alternatives. These facilities would be the main contributors to the residual risk at INTEC. DOE also analyzed two facility disposition alternatives for the New Waste Calcining Facility and the Fuel Processing Building and related facilities. Analysis of these larger facilities for multiple methods of closure shows the variations in costs associated with particular closure methods. The results are presented in Table 7, which lists the major facility, closure method, and the estimated cost.

Table 7. Facility disposition cost estimate summary.

	Estimated cost in 1998 millions of dollars by facility disposition alternative		
Facility name	Clean Closure	Performance-Based Closure	Closure to Landfill Standards
Tank Farm	$3,173	$169	$135
Bin sets	$536	$460	$271
Fuel Processing Building and Related Facilities	(a)	$57	$46
New Waste Calcining Facility	(a)	$42	$39

a. The Clean Closure Alternative was not evaluated for this facility.

The table shows the much higher costs for Clean Closure of the Tank Farm versus Performance-Based Closure or Closure to Landfill Standards. One way to compare the high end of facility disposition cost is that $3 billion for facility disposition is almost as much as the complete waste treatment and disposal cost for any of the Transuranic Separations Options.

The potential cost of closure highlights the tradeoff in value obtained for the investment in the facility disposition process. Cleaning the INTEC facilities analyzed in the EIS to background levels for radiation and hazardous materials probably could be done if enough taxpayer dollars were expended. Considering the potential future use of the INTEC land, an investment of billions of dollars to return only one part of INTEC to a pristine condition may not be in the best interest of the public and the Federal government.

7.0 UNCERTAINTY

As described in Section 5.5, the range of costs is based on computer simulations that predict the probability of actual costs. An overview of the cost simulation report is included in Appendix D. In

Table 6, three values are stated for each option: Expected Cost, Low Range, and High Range. There is a 10 percent chance that the completed project would cost less than the Low Range value. Similarly, there is a 95 percent chance that the completed project would cost less than the High Range value. The estimates included contingencies that address the project risk associated with the maturity of the project. Most projects had a contingency of about 30 percent due to the early development stage of the projects, which is consistent with the guidelines in the *INEEL Cost Estimating Guide* (LMITCO 1998).

DOE used professional judgement during the development of range estimates to account for project uniqueness, the difficulty of environmental permitting, and technological maturity. Professional judgement determiuations adjusted the estimated TPC either up or down depending on the difficulties or project delays that were anticipated. DOE historically has developed new technologies to fulfill the needs of unique radioactive wastes. Additional technology development would be conducted before project funds would be expended to construct full-scale facilities.

The ability of the technology to perform as planned is particularly important. Technologies key to projects may fail to operate as intended; as a result, the project may have to be abandoned or substantially reconfigured. External regulation of DOE facilities by the U.S. Nuclear Regulatory Commission (NRC) could increase the cost of all the alternatives and options. Of most significance would be the additional cost of upgrading existing facilities that were originally constructed to meet the different DOE guidelines and regulations of the past. DOE and NRC have jointly conducted pilot projects where NRC regulations have been implemented by certain DOE facilities. The capital costs for upgrading to NRC licensing requirements are estimated to range from an additional $6.7 million for the No Action Alternative to $474 million for the Planning Basis Option. These costs would be in addition to the costs estimated and reported elsewhere in this report.

Some of the estimated costs for the INEEL HLW Program relate to compliance with RCRA. HLW and mixed transuranic waste/SBW at INEEL is considered to be mixed waste and would require treatment to comply with the RCRA land disposal restrictions prior to disposal in a RCRA permitted facility. Alternatively, the wastes may be delisted from RCRA so that they could be disposed in a facility that is not RCRA permitted such as the proposed Yucca Mountain repository. RCRA delisting is assumed to consist of three elements:

- Development of delisting strategy including waste sampling and analysis
- Waste treatment including construction of facilities and operations
- Preparation and support for the delisting petition and follow-up

The costs for delisting and treatment are estimated to be approximately $3.6 billion dollars for the Planning Basis Option (Peel 1999c) including the cost for construction and operation of treatment facilities. The estimated RCRA cost has already been included in this report for all of the options. However, extended periods of time and effort may be required to delist the waste beyond the estimates in this report.

Other factors that contribute to uncertainty but were not readily quantifiable in the cost estimating process are discussed below.

- The planned HLW repository may not open in time for the waste to be shipped within the schedule assumptions for the INEEL HLW program. Space in the repository may be taken by waste from other sites before INEEL waste has been treated. Other disposal facilities for low-level waste or transuranic waste may close or run out of space before INEEL waste could be accepted.

- Federal appropriations by Congress are frequently less than the amounts requested by DOE.. These limitations may impede the progress of an alternative or option by lengthening the time for construction or operation and increasing the overall cost of the alternative or option.

- The number of HLW canisters for the Direct Cement Waste Option (18,000) is about twice the capacity of the current planning for the Yucca Mountain repository. Possible solutions are building a second repository, expanding the Yucca Mountain repository, or allowing another means of disposal through amending the Nuclear Waste Policy Act. A similar uncertainty exists for the Early Vitrification Option that would produce 11,700 HLW canisters. Some uncertainty was taken into account in the calculation of the cost range per canister for disposal. The expected cost per canister of $540,000 is bounded by a lower range of $479,000 and an upper range of $842,000 (Peel 1999a).

- When many projects are grouped together they form a complex system. Additional uncertainty is created due to the complexity. For example, one project may not function properly, causing the whole system to under-perform or possibly fail.

- A new cask system would need to be developed and licensed for transportation of HLW calcine for the Minimum INEEL Processing Alternative.

- Stakeholders may not support onsite disposal of LLW Class A or C type grout or vitrified LLW at INEEL. However, some alternatives and options do not require onsite disposal. Similarly, extended onsite storage of HLW due to non-availability of disposal sites may not be acceptable to stakeholders or regulators.

The waste treatment options described in this report are considered to be representative of several reasonable alternatives and options that were developed through the National Environmental Policy Act (NEPA) process. These cost estimates are unlikely to closely align with the current INEEL HLW program budget planning because the alternatives and options included are not the same. Other planning documents have been and are currently being prepared for various aspects of operation and closure of INEEL facilities such as the *INEEL End State Plan* and the *INEEL Comprehensive Facility and Land Use Plan*. Many assumptions for these documents are similar to assumptions used in this report. However, DOE does not intend to update this report to maintain consistency with other planning documents.

The costs for the CERCLA cleanup process for Waste Area Group 3 that will occur through the same time period are not included in this report. A CERCLA Record of Decision was finalized in October 1999 (DOE 1999b). Decisions reached through the CERCLA process may limit some Idaho HLW & FD EIS alternatives because of cumulative environmental and human health impacts. Analysis of these contingencies are beyond the scope of this report.

8.0 SENSITIVITY

The results of a cost estimate depend on the assumptions and bases used. Therefore, it is important to understand how the results would be affected if the assumptions change. Since this report is focused on supporting a decision on how to manage HLW and mixed transuranic waste/SBW, absolute differences are less important than the relative ranking of the alternatives and options.

8.1 Timing of Actions

Changing the timing of the actions may affect the relative cost of the alternatives or options depending on how much the start and finish of the projects would be changed. A prime example is the Minimum INEEL Processing Alternative. In one case for this alternative, HLW calcine is assumed to be shipped to Hanford from 2012 through 2025, and a new canister storage building would need to be constructed at Hanford. A Just-In-Time Shipping Scenario was analyzed that assumed HLW calcine would be shipped to Hanford from 2028 through 2030 and a new canister storage building would not be needed. The Just-In-Time Shipping Scenario would save about $0.5 billion compared with the other case of the Interim Storage Shipping Scenario as footnoted in Table 5.

8.2 Repository Cost

The disposal element of the cost estimates assumes that HLW would be sent to the proposed Yucca Mountain repository with a disposal cost of $540,000 per canister (Peel 1999b). This estimate was based on the *Analysis of the Total System Life Cycle Cost of the Civilian Radioactive Waste Management Program* (DOE 1998b) that assumed 20,004 canisters of DOE waste or spent nuclear fuel would be placed in the repository. The defense program cost of the repository was assumed to be $10.8 billion. A lower cost per canister would have the greatest effect on the Non-Separations Alternative. As illustrated in Figure 12, HLW disposal contributes from 40 percent to 70 percent of the total cost. A substantial reduction in the cost per canister could have a dramatic reduction in total cost but might still not result in any of the options under the Non-Separations Alternative becoming the lowest cost option that was analyzed.

8.3 Transportation

Transportation of wastes from one site to another to take advantage of existing or planned treatment facilities has sometimes been thought to cost more than building new facilities to perform the treatment at INEEL. As noted in Figure 12, the transportation costs for most alternatives and options are less than 10 percent of the total cost for most alternatives and options. The analysis indicates that transportation is not the dominant cost element in any of the alternatives or options. Even in the event of transportation costs being reduced or increased, the relative ranking of the alternative or option would be roughly the same.

8.4 Regulatory Framework

The management of radioactive and hazardous waste is governed by a complex set of laws, regulations, and guidelines that are subject to change and reinterpretation as explained in Section 6.2 of the Idaho HLW & FD EIS. The Idaho HLW & FD EIS and this Cost Report assumed that the proposed facilities would not be subject to external regulation by NRC. However, if the proposed facilities were to become subject to NRC licensing, all of the new facilities would be similarly affected with the exception of the No Action Alternative and Continued Current Operations Alternative (because no new facilities would be constructed). Section 7.0 explains the implications of NRC regulation.

Another possible impact of changing regulations is the new air emission controls that would be needed to comply with the Maximum Achievable Control Technology (MACT) requirements of EPA. MACT would apply to existing and proposed thermal treatment facilities including the existing New Waste Calcining Facility. The estimated cost for compliance with MACT ($76 million unescalated included in Continued Current Operations Alternative) has been factored into the cost estimates.

9.0 CONCLUSIONS

Several conclusions emerged through the cost analysis process. The conclusions are listed below.

- The Separations Alternative - Transuranic Separations - Grout in Tanks Option is the lowest cost option that would produce a waste form that could be accepted by disposal facilities.

- The Non-Separations Alternative - Direct Cement Waste Option is the highest cost option. However, the No Action and Continued Current Operations Alternatives would have other future costs beyond the year 2095 because final waste forms would not be produced under these alternatives. The costs beyond the year 2095 have not been estimated in the Cost Report.

- All of the waste processing alternatives and options except No Action would require a substantial increase in funding over current levels to be fully implemented. The No Action and Continued Current Operations Alternatives (alternatives that would not produce final waste forms) would have other future costs beyond the year 2095 that have not been estimated in the Cost Report. As a result, the No Action and Continued Current Operations Alternatives may ultimately represent the highest cost alternatives.

- The cost of disposal is the major determinant of the total cost to accomplish a waste processing alternative or option. Disposal costs are highest for the Non-Separations Alternative due to the relatively large volume of waste product.

- Transporting wastes for treatment or disposal at other DOE sites may be more cost effective than duplicating treatment or disposal facilities at INEEL.

- All of the cost estimates for the alternatives and options rely to some degree on the availability of waste disposal facilities that have not opened or may not be available to accept waste.

- Facility disposition costs would be much higher if clean closure methods were used at the Tank Farm and bin sets.

9.1 Funding

Current annual funding levels would be insufficient to implement any of the waste processing alternatives and options except No Action. The DOE report *Accelerating Cleanup: Paths to Closure* (DOE 1998d) assumes that funding for the INEEL programs will remain approximately at the same level through the year 2070. See Figures 14 and 15 for 5-year funding projections.

9.2 HLW Disposal

The cost of HLW disposal is the largest component contributing to total cost for most alternatives. Most of the waste processing alternatives and options would produce waste forms that would be suitable only for disposal at the proposed HLW repository. Alternatives or options that require a larger number of HLW canisters (i.e., Non-Separations) have a significant cost disadvantage. The cost for HLW disposal was calculated on a per-canister basis using the total inventory of canisters planned for disposal. Disposal costs vary greatly depending on the quantity of waste (number of canisters), waste type, and the disposal facility. Overall, disposal costs for the Transuranic Separations Option (calculated per cubic meter) are lower than other options due to lower costs for disposal at facilities other than the proposed HLW repository.

9.3 Offsite Treatment of Waste

Treatment of wastes from the INEEL HLW program at other DOE treatment facilities, specifically Hanford in the State of Washington, compares favorably with the least costly onsite waste processing alternatives and options. The cost for transportation of waste to other DOE treatment facilities or to disposal facilities is the smallest of the three components that were analyzed (i.e., treatment, transportation, and disposal).

9.4 Waste Disposal Uncertainty

Availability of adequate disposal capacity at the proposed a repository, LLW facilities, and WIPP is a major point of uncertainty for all of the waste processing alternatives and options with the exception of the No Action Alternative and Continued Current Operations Alternative. Assured disposal capacity is essential to completing program objectives. Contingencies for alternative waste disposal arrangements have not been factored into the estimates. Some planned facilities may not be open, and other existing facilities may be filled to capacity by the time INEEL waste is ready for shipment.

9.5 Facility Disposition Clean Closure

Of the facility disposition alternatives that were considered for the Tank Farm, Clean Closure would cost about 19 to 24 times more than Performance-Based Closure or Closure to Landfill Standards, respectively. The incremental increase in cost for Clean Closure of the bin sets is much smaller, but Clean Closure would cost 17 percent more than Performance-Based Closure or twice the cost for Closure to Landfill Standards.

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APPENDIX A

GLOSSARY

APPENDIX A - GLOSSARY

Terms in this glossary are defined based on the context in which they are to be used in this Cost Report.

alternative

A major strategy or choice to address the EIS "Purpose and Need" statement, as opposed to the engineering options available to achieve the goal of an alternative.

bin set(s)

A series of watertight reinforced concrete vaults (see Calcined Solids Storage Facilities).

calcination

The act or process by which a substance is heated to a high temperature that is below the melting or fusing point. Calcination results in moisture removal, organic destruction, and high temperature chemical reactions. The final waste form is a dense powder.

calcine

To heat a substance to a high temperature, but below its melting point, driving off moisture and volatile constituents. When used as a noun, this term is also used to refer to the material produced by this process.

Calcined Solids Storage Facilities

A series of watertight reinforced concrete vaults commonly referred to as bin sets. The vaults contain three to seven stainless steel storage bins for the storage of calcined high-level waste generated in the New Waste Calcining Facility. Calcined solids from New Waste Calcining Facility are transferred pneumatically to the Calcined Solids Storage Facilities through buried underground transfer lines. This report refers to the Calcined Solids Storage Facility as "bin sets."

canister

A container for high-level waste such as calcined, cemented, or vitrified wastes.

cask

A specially designed container used for shipping, storage, and disposal of radioactive material that affords protection from accidents and provides shielding for radioactive material. The design includes special shielding, handling, and sealing features to provide positive containment and minimize personnel exposure.

characterization

The determination of waste composition and properties, whether by review of process history, nondestructive examination or assay, or sampling and analysis, generally done for the purpose of determining appropriate storage, treatment, handling, transport, and disposal requirements.

Class A Type Waste

Radioactive waste that is usually segregated from other wastes at disposal sites to ensure the stability of the disposal site. Class A type waste can be disposed along with other wastes if rigorous requirements for stability are met. Class A type waste can be in the form of cement grout or other primarily solid material.

Class C Type Waste

Radioactive waste that is suitable for near surface disposal but due to its radionuclide concentrations must meet vigorous requirements for waste form stability. Class C type waste requires additional protective measures at the disposal facility to protect against inadvertent intrusion. Class C type waste can be in the form of cement grout or other primarily solid material.

Code of Federal Regulations (CFR)

A document containing the regulations of Federal departments and agencies.

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)

A Federal law (also known as "Superfund") that provides a comprehensive framework to deal with past or abandoned hazardous materials. The Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) provides for liability, compensation, cleanup, and emergency response for hazardous substances released into the environment that could endanger public health, welfare, or the environment, as well as the cleanup of inactive hazardous waste disposal sites. CERCLA has jurisdiction over any release or threatened release of any "hazardous substance" to the environment. Under CERCLA, the definition of "hazardous" is much broader than under the Resource Conservation and Recovery Act, and the hazardous substance need not be a waste. If a site meets the CERCLA requirements for designation, it is ranked along with other "Superfund" sites and listed on the National Priorities List. This ranking and listing is the U.S. Environmental Protection Agency's way of determining which sites have the highest priority for cleanup.

construction

Any combination of engineering, procurement, erection, installation, assembly, or fabrication activities involved to create a new facility, or modify an existing facility.

contact-handled

Radioactive materials, usually packaged in some form, that emit radiation levels low enough to permit close and unshielded manipulation by workers.

contaminant

Any chemical or radioactive substance that contaminates (pollutes) air, soil, or water. This term also refers to any hazardous substance that does not occur naturally or that occurs at levels greater than those naturally occurring in the surrounding environment (background).

contamination

The presence of unwanted chemical or radioactive material on the surfaces of structures, areas, objects, or externally or internally to personnel.

deactivation

Removing potentially hazardous (non-waste) materials from the process vessels and transport systems, de-energizing power supplies, disconnecting or reloading utilities, and other actions to place the facility in an interim state that requires minimal surveillance and maintenance.

decommissioning

The process of removing a facility from operation followed by decontamination, entombment, dismantlement, or conversion to another use.

decontamination

The actions taken to reduce or remove substances that pose a substantial present or potential hazard to human health or the environment, such as radioactive contamination from facilities, soil, or equipment by washing, chemical action, mechanical cleaning, or other techniques.

delisting

A regulatory process to exclude a waste produced at a particular facility from the lists in Subpart D of 40 CFR Part 261. To be eligible for an exclusion, a listed waste must not meet the criteria for which it was listed, exhibit any hazardous waste characteristics, and exhibit any other factors (including additional constituents) that could cause the waste to be a hazardous waste.

discount rate

The name given to an investor's minimum acceptable rate of return when it is used to adjust future benefits and costs to time-equivalent. A "market" discount rate reflects expectations about future inflation or deflation and is based on a rate observed in the marketplace.

disposal

Emplacement of high-level radioactive waste, spent nuclear fuel, or other highly radioactive material in a repository with no foreseeable intent of recovery, whether or not such emplacement permits the recovery of such waste.

disposal package

The primary container that holds, and is in contact with, solidified high-level radioactive waste, spent nuclear fuel, or other radioactive materials, and any overpacks that are emplaced at a repository.

disposal site

The area dedicated to waste disposal and related activities.

disposition

As used in this EIS, disposition is the set of activities performed on INTEC facilities that no longer have a mission so that they can be placed in a condition consistent with INEEL's future land use plans. These activities could include closure, deactivation, decontamination, and decommissioning.

DOE Orders

Internal requirements of the U.S. Department of Energy (DOE) that establish DOE policy and procedures, including those for compliance with applicable laws.

escalation

Expected future changes in relative prices (inflation/deflation).

facilities

Buildings and other structures, their functional systems and equipment, and other fixed systems and equipment installed therein.

Federal Facility Compliance Act (FFCA)

Federal law signed in October 1992 amending the Resource Conservation and Recovery Act. The objective of the FFCA is to bring all Federal facilities into compliance with applicable Federal and State hazardous waste laws, to waive Federal sovereign immunity under those laws, and to allow the imposition of fines and penalties. The law also requires the U.S. Department of Energy to submit an inventory of all its mixed waste and to develop a treatment plan for mixed wastes.

Federal Facility Agreement and Consent Order (FFA and CO)

A binding agreement, negotiated pursuant to Section 120 of CERCLA, signed by DOE, the Environmental Protection Agency Region 10, and the State of Idaho, to coordinate cleanup activities at the INEEL. The FFA and CO and its Action Plan outline the remedial action process that will encompass all investigation of hazardous substance release sites. The FFA and CO superseded the Consent Order and Compliance Agreement.

groundwater

Water occurring beneath the earth's surface in the intervals between soil grains, in fractures, and in porous formations.

grout

A fluid mixture of cement-like materials and liquid waste that sets up as a solid mass and is used for waste fixation, immobilization, and stabilization purposes.

hazardous material

A substance or material, including a hazardous substance, which has been determined by the U.S. Secretary of Transportation to be capable of posing an unreasonable risk to health, safety, and property when transported in commerce.

hazardous substance

Any substance that when released to the environment in an uncontrolled or unpermitted fashion becomes subject to the reporting and possible response provisions of the Clean Water Act and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).

hazardous waste

Under the Resource Conservation and Recovery Act, a solid waste, or combination of solid wastes, which because of its quantity, concentration, or physical, chemical, or infectious characteristics may (a) cause, or significantly contribute to an increase in mortality or an increase in serious irreversible, or incapacitating reversible, illness; or (b) pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, or disposed of, or otherwise managed. Source material, special nuclear material, and by-product material, as defined by the Atomic Energy Act, are specifically excluded from the definition of solid waste.

high-level waste

DOE Manual 435.1-1 defines HLW as the "highly radioactive waste material resulting from the reprocessing of spent nuclear fuel, including liquid waste produced directly in reprocessing and any solid material derived from such liquid waste that contains fission products in sufficient concentrations; and other highly radioactive material that is determined, consistent with existing law, to require permanent isolation."

hot isostatic press (HIP)

A process that stabilizes and reduces the volume of high-level waste where calcined waste is retrieved, mixed with suitable additives, canned, and then heated and pressed in the container to form a ceramic-like material. The resulting waste form is expected to be equivalent to vitrified waste and potentially acceptable as a waste form for permanent disposal in a repository.

Idaho Settlement Agreement

A court-ordered agreement among the State of Idaho, DOE, and the Navy. Under the Settlement Agreement, DOE must meet certain conditions relating to the management of high-level waste at the INEEL.

immobilization

A process (e.g., solidification or vitrification) used to stabilize waste. Immobilizing the waste inhibits the release of waste to the environment.

institutional control

The period of time when a site is under active governmental control. For the purposes of this analysis, the time period of 2000 through 2095 is assumed.

interim storage

Temporary storage of waste until an ultimate disposal plan is approved and implemented.

land disposal restrictions

A Resource Conservation and Recovery Act (RCRA) program that restricts land disposal of RCRA hazardous and RCRA mixed wastes and requires treatment to promulgated treatment standards. Land Disposal Restrictions identify hazardous wastes that are restricted from land disposal and define those limited circumstances under which an otherwise prohibited waste may continue to be land disposed.

landfill

A solid waste facility or part of a facility for the permanent disposal of solid wastes in or on the land. This includes a sanitary landfill, balefill, landspreading disposal facility, or a hazardous waste, problem waste, limited purpose, inert, or demolition waste landfill.

life cycle cost (LCC)

The anticipated costs associated with a project or program alternative throughout its life, including the impacts of inflation, the time-value of money, and operating and disposition costs.

long-term storage

The storage of hazardous waste (a) onsite (a generator site) for a period of 90 days or greater, other than in a satellite accumulation area, or (b) offsite in a properly managed treatment, storage, or disposal facility for any period of time.

low-level waste (LLW)

Waste that contains radioactivity and is not classified as high-level waste, transuranic waste, or spent nuclear fuel, or by-product tailings containing uranium or thorium from processed ore (as defined in Section II e(2) of the Atomic Energy Act).

low-level mixed waste (LLMW)

Waste that contains both hazardous waste under the Resource Conservation and Recovery Act and source, special nuclear, or by-product material subject to the Atomic Energy Act of 1954 (42 USC 2011, *et seq.*).

Maximum Achievable Control Technology (MACT)

Technology for achieving the maximum control of emissions from major sources of hazardous air pollutants, using particularly stringent control devices as prescribed in 40 CFR 63.41 for new sources and in 40 CFR 63.51 for existing sources.

metric tons of heavy metal (MTHM)

Quantities of unirradiated and spent nuclear fuel and targets are traditionally expressed in terms of metric tons of heavy metal (typically uranium), without the inclusion of other materials, such as cladding, alloy materials, and structural materials. A metric ton is 1,000 kilograms, which is equal to about 2,200 pounds. With respect to high-level waste, DOE has historically assumed a canister of defense program high-level waste contains 0.5 MTHM.

mixed waste

Waste that contains both hazardous wastes under the Resource Conservation and Recovery Act and source, special nuclear, or by-product material subject to the Atomic Energy Act of 1954.

permanent disposal

For high-level waste, the term means emplacement in a repository for high-level radioactive waste, spent nuclear fuel, or other highly radioactive material with no foreseeable intent of recovery, whether or not such emplacement permits the recovery of such waste.

public

Anyone outside the DOE site boundary. With respect to accidents analyzed in this EIS, anyone outside the DOE site boundary at the time of an accident.

public comment

A written or verbal remark or statement of fact or opinion made in response to a position proposed by a government agency.

radiation (ionizing radiation)

Alpha particles, beta particles, gamma rays, x-rays, neutrons, high-speed electrons, high-speed protons, and other particles capable of producing ions. Radiation, as it is used here, does not include nonionizing radiation such as radio- or microwaves, or visible, infrared, or ultraviolet light.

radioactive waste

Waste that is managed for its radioactive content.

radioactivity

The property or characteristic of material to spontaneously disintegrate with the emission of energy in the form of radiation. The unit of radioactivity is the curie (or becquerel).

radionuclide

A distinct nuclear species; the nuclear entity analogous to an element in chemistry that has distinct nuclear properties (e.g., cesium-137, uranium-238, technetium-99).

RCRA

See Resource Conservation and Recovery Act.

RCRA interim status facility

Hazardous waste management facilities (that is, treatment, storage, or disposal facilities) subject to Resource Conservation and Recovery Act requirements that were in existence on the effective date of regulations are considered to have been issued a permit on an interim basis as long as they have met notification and permit application submission requirements. Such facilities are required to meet interim status standards until they have been issued a final permit or until their interim status is withdrawn.

RCRA storage

A facility used to store Resource Conservation and Recovery Act (RCRA) hazardous waste for greater than 90 days. To be in compliance with the regulatory requirements of RCRA, the facility must meet both documentation requirements (for example, contingency and waste analysis plans) and physical requirements (for example, specific aisle widths and separation of incompatible wastes).

Record of Decision (ROD)

A public document that records the final decision(s) concerning a proposed agency action. The Record of Decision is based in whole or in part on information and technical analysis generated either during the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) process or the National Environmental Policy Act process, both of which take into consideration public comments and community concerns.

remote-handled waste

This term refers to radioactive waste that must be handled at a distance to protect workers from unnecessary exposure.

remote handling

The handling of wastes from a distance to protect human operators from unnecessary exposure.

repository

A deep (on the order of 600 meters [1,928 feet] or more) underground mined array of tunnels used for permanent disposal of radioactive waste. For HLW, any system licensed by the U.S. Nuclear Regulatory Commission that is intended to be used for, or may be used for, the permanent deep disposal of high-level radioactive waste and spent nuclear fuel, whether or not the system is designed to permit the recovery, for a limited period during initial operation, of any materials placed in the system. It includes both surface and subsurface areas at which high-level radioactive waste and spent nuclear fuel handling activities are conducted as defined in the Nuclear Waste Policy Act [42 U.S.C. 10101]. For defense transuranic waste, the repository is defined as the Waste Isolation Pilot Plant Facility.

representative

An attribute of an analysis that means the analytical result can represent the results of hypothetical analyses of other similar scenarios. The hypothetical, unanalyzed scenarios are expected to have outcomes similar enough to let the representative analysis stand for the unanalyzed scenarios. The representative analysis does not necessarily produce an analysis that bounds the analyses for all similar scenarios.

reprocessing (of spent nuclear fuel)

Processing of reactor-irradiated nuclear material (primarily spent nuclear fuel) to recover fissile and fertile material, in order to recycle such materials. Historically, reprocessing has involved aqueous chemical separations of elements (typically uranium or plutonium) from undesired elements in the fuel.

Resource Conservation and Recovery Act (RCRA)

A Federal law addressing the management of waste. Subtitle C of the law addresses hazardous waste under which a waste must either be "listed" on one of the U.S. Environmental Protection Agency's (EPA's) hazardous waste lists or meet one of EPA's four hazardous characteristics of ignitability, corrosivity, reactivity, or toxicity, as measured using the toxicity characteristic leaching procedure. Cradle-to-grave management of wastes classified as RCRA hazardous wastes must meet stringent guidelines for environmental protection as required by the law. These guidelines include regulation of transport, treatment, storage, and disposal of RCRA-defined hazardous waste. Subtitle D of the law addresses the management of nonhazardous, nonradioactive, solid waste such as municipal wastes.

road ready

Waste material that has been treated and placed in containers that are transportable and ready for shipment to a repository or interim storage facility.

scope

The range of actions, alternatives, and impacts to be considered in a document prepared pursuant to the National Environmental Policy Act.

sodium bearing waste/SBW

Liquid mixed transuranic waste generated from decontamination of process equipment and other miscellaneous activities at the Idaho Nuclear Technology and Engineering Center.

solidification

Changing a substance from liquid to solid by cooling it below its melting temperature or by adding solid-forming materials such as Portland cement. This term also can refer to removing waste from wastewater.

spent nuclear fuel

Fuel that has been withdrawn from a nuclear reactor following irradiation, the constituent elements of which have not been separated.

stabilization

Treatment of waste to protect the environment from contamination. This includes rendering a waste immobile or safe for handling and disposal.

stakeholder

Any person or organization interested in or affected by DOE activities. Stakeholders may include representatives from Federal agencies, State agencies, Congress, Native American Tribes, unions, educational groups, business and industry, environmental groups, and members of the general public.

storage

Retention of high-level radioactive waste, spent nuclear fuel, transuranic or hazardous wastes with the intent to recover such waste or fuel for subsequent use, processing, or disposal.

Tank Farm

An installation of multiple adjacent tanks at INTEC interconnected for storage of liquid radioactive waste.

time-value of money

The time-dependent value of money arising from price inflation/deflation and from its earning potential over time.

transuranic waste

Waste containing more than 100 nanocuries per gram of waste of alpha-emitting transuranic isotopes, with half-lives greater than 20 years, except for (a) high-level radioactive waste; (b) waste that the U.S. Department of Energy has determined, with the concurrence of the Administrator of the U.S. Environmental Protection Agency, does not need the degree of isolation required by 40 CFR 191; or (c) waste that the U.S. Nuclear Regulatory Commission has approved for disposal on a case-by-case basis in accordance with 10 CFR 61.

transuranic radionuclide

Any radionuclide having an atomic number greater than 92.

treatment

Any activity that alters the chemical or physical nature of a hazardous waste to reduce its toxicity, volume, or mobility or renders it amenable for transport, storage, or disposal.

treatment facility

Land area, structures, and/or equipment used for the treatment of waste or spent nuclear fuel.

TRUPACT

Transuranic Package Transporter. (See TRUPACT II Container.)

TRUPACT II Container

The package designed to transport contact-handled transuranic waste to the Waste Isolation Pilot Plant site. It is a cylinder with a flat bottom and a domed top that is transported in the upright position. The major components of the TRUPACT-II are an inner, sealed, stainless steel containment vessel within an outer, sealed, stainless steel containment vessel. Each containment vessel is nonvented and capable of withstanding 50 pounds per square inch of pressure. The inner containment vessel cavity is 6 feet in diameter and 6.75 feet tall, with a capability of transporting fourteen 55-gallon drums, two standard waste boxes, or one 10-drum overpack.

uncertainty

A state of incomplete knowledge about the inputs to an economic analysis.

Universal Treatment Standards (UTS)

For hazardous waste subject to Land Disposal Restrictions under the Resource Conservation and Recovery Act, the Universal Treatment Standards identified in 40 CFR 268.48 are the concentration standards to which the underlying hazardous constituents must be treated prior to land disposal.

vitrification

A method of immobilizing waste (e.g., radioactive, hazardous, and mixed). This involves combining other materials and waste and melting the mixture into glass. The purpose of this process is to permanently immobilize the waste so it can be isolated from the environment.

waste acceptance criteria

The requirements specifying the characteristics of waste and waste packaging acceptable to a waste receiving facility; and the documents and processes the generator needs to certify that waste meets applicable requirements.

waste acceptance specifications

The functions to be performed and the technical requirements for a Waste Acceptance System for accepting spent nuclear fuel and high-level waste into the Civilian Radioactive Waste Management System according to the *Waste Acceptance System Requirements Document* (DOE/RW-0352P, January 1993, Office of Civilian Radioactive Waste Management).

Waste Area Group (WAG)

There are ten groupings of hazardous waste release sites under the INEEL Federal Facility Agreement and Consent Order (FFA and CO). Groupings are for efficiency in managing the assessment and cleanup process. Nine of these WAGs are associated with specific facilities, and the tenth is associated with the remaining miscellaneous facilities. Each WAG may be broken down into individual operable units.

waste certification

A process by which a waste generator certifies that a given waste or waste stream meets the waste acceptance criteria of the facility to which the generator intends to transport waste for treatment, storage, or disposal. A combination of waste characterization, documentation, quality assurance, and periodic audits of the certification program accomplish certification.

waste characterization

See *characterization*.

Waste Isolation Pilot Plant (WIPP)

A DOE facility near Carlsbad, New Mexico, authorized to dispose of defense-generated transuranic waste in a deep repository in a salt layer 2,150 feet underground.

waste stream

A waste or group of wastes with similar physical form, radiological properties, U.S. Environmental Protection Agency waste codes, or associated land disposal restriction treatment standards. It may be the result of one or more processes or operations.

Yucca Mountain Site

A candidate site in Nye County, Nevada that is being considered as a repository for disposal of spent nuclear fuel and high-level waste. For purposes of analysis, this report assumes Yucca Mountain will ultimately receive INEEL's high-level waste. This assumption may not be substantiated after further analysis and planning by DOE.

APPENDIX B

LIFE CYCLE COSTS

APPENDIX B - LIFE CYCLE COSTS

Life cycle costs (LCCs) were developed for the alternatives in the Idaho High-Level Waste and Facilities Disposition Environmental Impact Statement (Idaho HLW & FD EIS) following standard procedures used at the Idaho National Engineering and Environmental Laboratory (INEEL) as outlined in the *INEEL Cost Estimating Guide* (LMITCO 1998). The LCC identifies activity costs in three sections: Total Project Cost (TPC), Operations, and Post Operations. TPCs include permitting, direct and indirect construction, general and administrative, procurement fees, engineering inspection, project management, construction management, escalation, and contingency generated to match the schedule for the project. Operation costs include supervision, labor, maintenance, procurement, utilities, consumables, and disposal costs. Post-operation costs include decommissioning, decontamination, and demolition.

A team of engineers and estimators reviewed the life cycle estimates that had been prepared at the project level. The team evaluated assumptions and uncertainties that were factored into the estimates and the adequacy of the contingency. Revised project estimates were then combined in range estimate simulation runs for the alternatives (see Appendix D, Probabilistic Cost Simulation Study). The following assumptions were prepared to form the basis of the detailed engineering estimates.

- Start and finish dates were provided for the project.
- All costs were initially estimated in 1998 dollars and then escalated.
- Costs (with the exception of construction escalation) were escalated at 2.8 percent compounded annually (or other applicable rates) then discounted by 6.1 percent to 1998 current-day dollars, per Office of Management and Budget (OMB) Circular 94-A (OMB 1992).
- Closure cost estimates were based on historical data (see Section 5.4).

An example of an LCC estimate sheet is shown in Table B-1. (The actual spreadsheet covers all years of the proposed project; Table B-1 only shows the first three years.) The spreadsheet presents the estimated project cost by year for the life of the project expressed in unescalated (present day or FY98 values), escalated, and discounted dollars. Unescalated costs are costs estimated in 1998 dollars for all the years of the life of the project. The escalated costs are the 1998 costs increased by a factor for inflation (from

Table B-1. Example of a portion of the life cycle cost estimate spreadsheet.

			1998	1999	2000
Early Vitrification Option(P88)		Fiscal year	1998	1999	2000
Life-Cycle Cost (LCC) Analysis	(REV 2)	counting year	0	1	2
		Escalation Factor	1	1.024	1.052672
(ALL COST X1000)					
Other Project Cost (OPC)					
OPC unescalated					
Conceptual Design, Project Mgt, & Permitting			36027	36027	36027
Testing and Start-up					
Total OPC (unescalated)			36027	36027	36027
plus escalation of			7166.835	7166.835	7166.835
plus management reserve of			0	0	0
plus contingency of			11435.83	11435.83	11435.83
Total OPC including escalation, mgt reserve, & contingency			54629.66	54629.66	54629.66
Total Estimated Cost (TEC)					
TEC unescalated					
Title Design, Inspection					
Project mgt					
Construction Mgt					
Construction, Equip, G&A & Procurement					
Total TEC (unescalated)			0	0	0
plus escalation of			0	0	0
plus management reserve of			0	0	0
plus contingency of			0	0	0
Total TEC including escalation, mgt reserve, contingency			0	0	0
Total Project Cost (TPC)					
TPC unescalated			36027	36027	36027
plus escalation of			7167	7167	7167
plus management reserve of			0	0	0
plus contingency of			11436	11436	11436
Total TPC including esc, mgt res, contingency			54630	54630	54630
discount factor @ OMB discount rate of	0.061	for escalated costs	1.000	1.061	1.126
Discounted Annual Cost			54630	51489	48529

Table B-1. (Continued).

Early Vitrification Option(P88)			Fiscal year	1998	1999	2000
Operations	2080 hr-shift/yr.					
Facility/Administration	7					
Managers		1 FTE @	125 / hr.			
Engineers		1 FTE @	108 / hr.			
Other Tech.		2 FTE @	85 / hr.			
Administration/Support		3 FTE @	65 / hr.			
Operations/Process Facility	114					
Managers		1 FTE @	125 / hr.			
Engineers		2 FTE @	108 / hr.			
Other Tech.		2 FTE @	85 / hr.			
Supervisors		8 FTE @	85 / hr.			
Administration/Support		13 FTE @	65 / hr.			
Operators		44 FTE @	65 / hr.			
Maintenance		44 FTE @	65 / hr.			
Procurement		11724 units	10000 ea.			
CANS		612 units	8000			
Boro Silicate		1225000 kg @	4.4 / kg			
Utilities		22739000 kWh/yr	0.0829 $/kWh			
STEAM		46000000 lb/yr	0.015 $/lb			
Maintenance of Equipment		0.08 of	84573.23			
Building Maintenance		0.02 of	147634.3			
Disposal Hg	M3/YR	0.3	2500 / M3			
Operations subtotal (unescalated)				0	0	0
plus Escalation				0	0	0
plus Operations Contingency @		0.3		0	0	0
Total Operations (w/ escalation & contingency)				0	0	0
discount factor @ OMB discount rate of		0.061	for escalated costs	1.000	1.061	1.126
Discounted Annual Cost				0	0	0
Post Operations						
Decommission		0.2 of	Engineering costs			
Decontamination		0.05 of	Pre-operation Costs			
Demolition		0.08 of	Pre-operation Costs			

Table B-1. (Continued).

Early Vitrification Option(P88)		Fiscal year	1998	1999	2000
Post-Operations Subtotal (unescalated)			0	0	0
plus Escalation			0	0	0
plus Post-Operations Contingency @	0.3		0	0	0
Total Post-Operations (w/ escalation & contingency)			0	0	0
discount factor @ OMB discount rate of	0.061	for escalated costs	1.000	1.061	1.126
Discounted Annual Cost			0	0	0
Total Cost (unescalated)			36027	36027	36027
Cumulative Total LCC (unescalated)			36027	72054	108081
Total Cost (w/ escalation, mgt reserve, & contingency)			54630	54630	54630
Cumulative Total LCC (escalated)			54630	109259	163889
discount factor @ OMB discount rate of	0.061	for escalated costs	1.000	1.061	1.126
Discounted Annual Cost			54630	51489	48529
Cumulative Discounted LCC			54630	106119	154647

OMB Circular-94-A). Construction escalation costs were matched to the schedule and cost generated by cost estimating and by prorating the escalation for expenditures that would be incurred during construction. The discounted cost is the escalated cost decreased by a factor equal to the earning value of the money. The discounted LCC is determined by adding the escalated annual construction, operations, and post-operation costs together for a total annual cost then discounting each year's annual cost to the base year using OMB's discount rate of 6.1 percent (as described in *Departmental Price Change Index* (DOE 1997). The cumulative discounted cost is calculated by adding the discounted annual costs together.

Figure B-1 illustrates the components of the life cycle estimating process with regard to the probabilistic cost for the options in the Idaho HLW & FD EIS. The LMITCO LCCs were based on range of magnitude estimates, and TtNUS costs were based on scaled unit costs. LMITCO estimated costs for projects at INEEL, and TtNUS estimated costs for offsite projects such as transportation and offsite disposal. The output of the life cycle estimates became the input to the project range estimates described in Section 6 of this report.

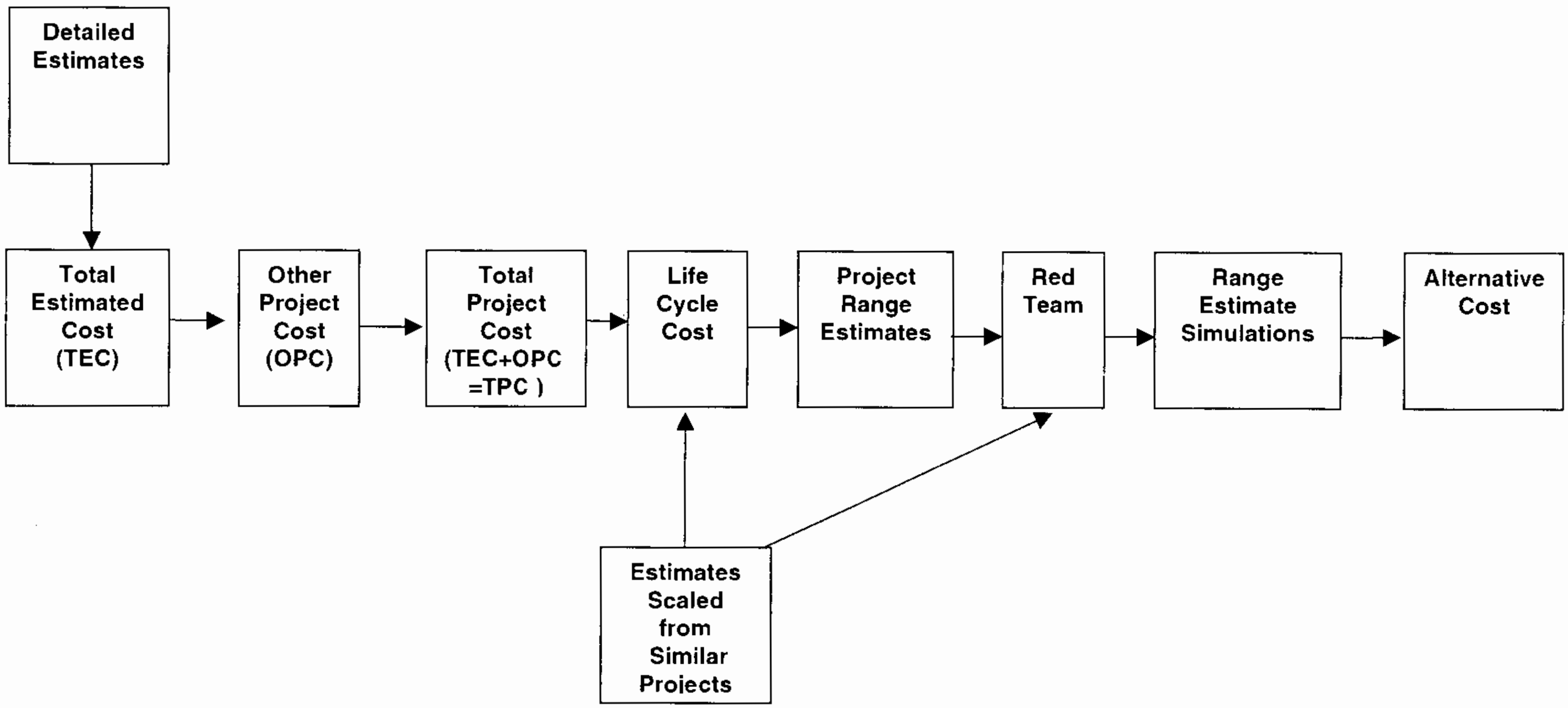


Figure B-1. Idaho HLW EIS cost estimating process.

References

DOE (U.S. Department of Energy), 1997, *Departmental Price Change Index, FY1999 Guidance, Anticipated Economic Escalation Rates, DOE Construction Projects and Operating Expenses*, January.

LMITCO (Lockheed Martin Idaho Technologies Company), 1998, *INEEL Cost Estimating Guide*, Rev. 2, Idaho Falls, Idaho.

OMB (Office of Management and Budget), 1992, *Guidelines and Discount Rates for Benefit – Cost Analysis of Federal Programs*, Circular No. A-94, Washington, D.C., October 29.

APPENDIX C

UNIT COSTS FOR SCALED PROJECTS

APPENDIX C - UNIT COSTS FOR SCALED PROJECTS

Most estimates for projects to be conducted offsite were prepared using a cost scaling approach also known as the specific analogy method. The scaling method was used for projects such as transportation to offsite treatment facilities or disposal facilities and disposal of waste at facilities away from the INEEL. The scaling method was used because published cost information was available for waste transportation and disposal.

Figure C-1 illustrates the process that was used to develop the scaled estimates and shows how the scaled estimates relate to other estimates that were prepared for the project. The cost team surveyed other related DOE programs and commercial facilities to obtain representative costs for transportation and disposal services. A range of costs was determined through consideration of the phase of the project or service (i.e., facility may be built but not yet receiving waste) and the market price of services offered by different contracts. Unit costs were expressed in the cost per mile per cubic meter of waste for transportation by truck or rail. Specific rates were calculated for the various waste types and the modes of transportation. The cost team then applied the appropriate unit rates to the volumes of waste or the number of waste shipments. For example, under the Full Separations Option-Offsite Facility Disposal Option, LLW Class A type grout was assumed to be disposed at Envirocare at a cost of $10,395,000 assuming the unit cost of $385 per cubic meter of waste (equal to $10.90 per cubic foot) (see Table C-1) (Peel 1999).

DOE used standard engineering assumptions to form the basis of the detailed engineering estimates. Some of the specific assumptions are:

- Existing sources of cost data were determined to be valid [e.g., Commercial Disposal Policy Analysis for Low-Level and Mixed Low Level Wastes (DOE 1999)], which enabled the cost team to proceed without having to start from scratch on each estimate.

- Estimates were initially developed for transportation of various types of waste based on accepted cost studies for those wastes. Most of the references included high and low ranges for the costs.

- Cost ranges were developed for other wastes by making assumptions such as more total waste going to a repository or less waste going to a repository that was assumed to have a fixed total cost.

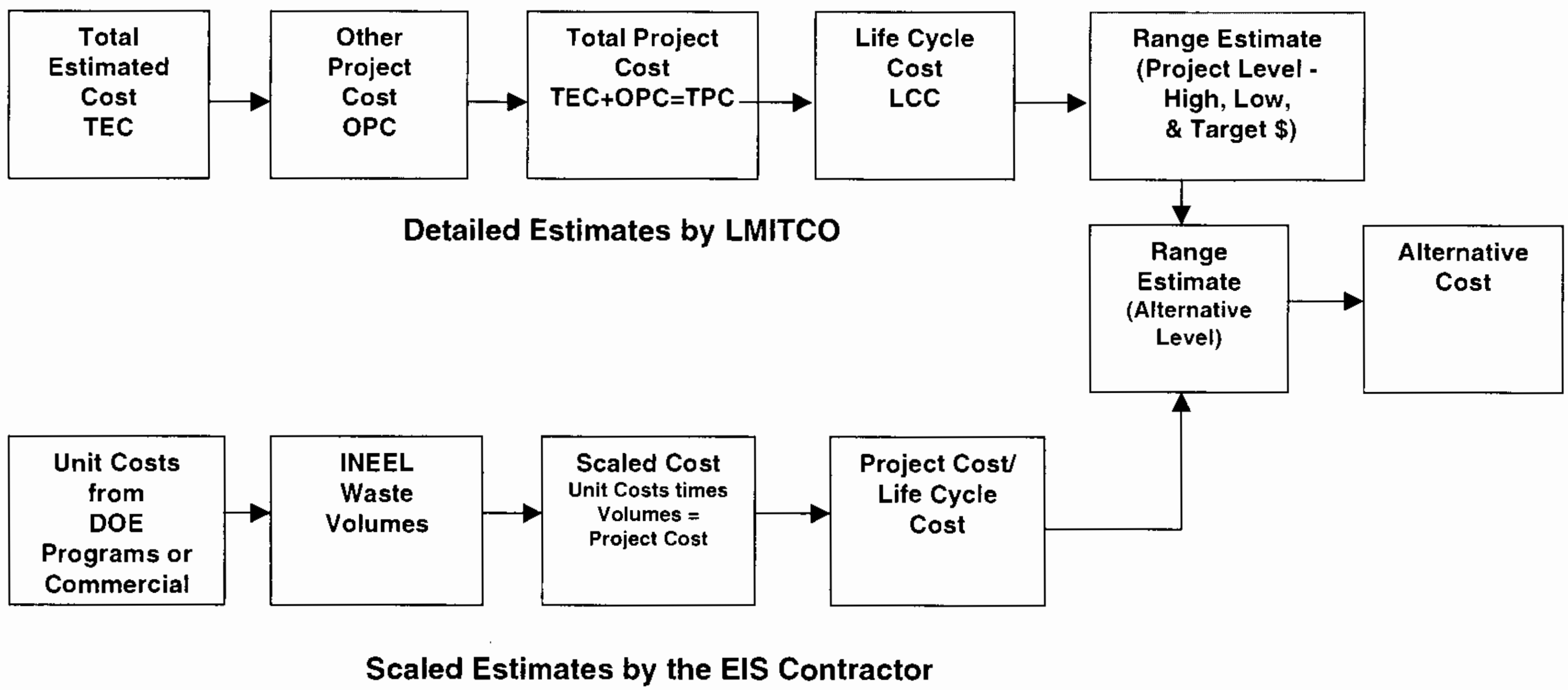


Figure C-1. Scaled costs related to cost estimating process.

Table C-1. Example of waste disposal cost scaling – LLW Class A type grout offsite disposal.

Waste volume in cubic meters	Expected unit cost per cubic meter	Low unit cost per cubic meter	High unit cost per cubic meter	Expected project cost
27,000	$385	$160	$600	$10,395,000

Additional assumptions were developed to be used in life cycle estimates such as:

- Start and finish dates for the project
- Escalation and discount rates – DOE headquarters guidance was used consistently in agreement with Office of Management and Budget (OMB) Circular A-94 (OMB 1992)
- Basis year for the estimate – 1998 dollars were used for all unescalated, non-discounted costs
- Cost elements calculated in three phases of the project–pre-operational, operational, and post operations

References

DOE (U.S. Department of Energy), 1999, *Commercial Disposal Policy Analysis for Low-Level and Mixed Low-Level Wastes*.

OMB (Office of Management and Budget), 1992, *Guidelines and Discount Rates for Benefit – Cost Analysis of Federal Programs*, Circular No. A-94, Washington, D.C., October 29.

Peel, R. C., 1999, *National Geologic Repository Cost Estimate Calculation*, Rogers & Associates Engineering, March 15.

APPENDIX D

PROBABILISTIC COST SIMULATION STUDY

APPENDIX D - PROBABILISTIC COST SIMULATION

The purpose of this appendix is to summarize the probabilistic addition of the cost estimate and uncertainty data from each project to calculate derived range estimates for each of the 16 waste-processing alternative options/scenarios (see Section 3.1). Results of the study represent comparable but not absolute values for the alternatives being considered. The team working on the probabilistic costs included representatives from DOE, LMITCO, TtNUS, and two TtNUS subcontractors, Rogers & Associates Engineering and David Miller & Associates. The full report of the *Probabilistic Cost Simulation Study of the Idaho HLW & FD EIS* (Probabilistic Cost Study) is found in DMA (1999). The following parameters are presented in the probabilistic cost simulation study:

- The expected total cost for each alternative.
- The theoretical maximum and minimum expected total cost for each alternative.
- Percentile data regarding the expected total cost for each alternative.
- Frequency distribution charts showing the results of 2,000 simulation trials for each alternative.
- Summary charts that compare the range estimates and cost components for 13 of the 16 waste-processing alternatives. The other three are for the Minimum INEEL Processing Alternative and are presented as a subset of the main alternative.

DOE created two general types of cost estimates provided during the course of this study.

Tetra Tech NUS

TtNUS provided costs based on unit rates for the transportation projects and most of the disposal projects. For the transportation projects, TtNUS estimated the number of shipments; transportation distance; and low, high, and target unit costs to arrive at the target cost for each transportation project, as well as the theoretical minimum and maximum possible costs for that project. For the offsite disposal projects, TtNUS used either the volumes of waste or number of canisters to estimate the low, high, and target unit costs to arrive at the target cost for each disposal project, as well as the theoretical minimum and maximum possible cost for that project. Additional information regarding the methodology and data used to derive these cost estimates is available in the Probabilistic Cost Study (DMA 1999).

- TtNUS provided unescalated 1998 costs for 31 of the 75 projects reviewed in this study.

- The final cost estimates for these 31 projects were provided by Rogers & Associates in an Excel spreadsheet named "Unitcost 5-28-99" (dated 5/28/99).

Lockheed Martin Idaho Technologies, Inc.

LMITCO provided detailed cost estimates for individual components of each of the remaining projects. These estimates were derived using a variety of methodologies including "bottoms-up" costing where the project's components are quantified, priced, and assigned labor; and "Expert Opinion" where the opinion of a knowledgeable expert is sought to assist in pricing a project component or system. Additional information regarding the methodology used to derive these cost estimates is available in Section 5.0 of the Idaho HLW & FD EIS Cost Report.

- LMITCO provided unescalated 1998 costs for 44 of the 75 projects reviewed in this study.

- Each of the 44 projects is made up of between 1 and 10 cost components; 368 components are included in the 44 LMITCO projects.

- For each of the 368 cost components, LMITCO provided the following data:

  - The lowest theoretical possible cost.
  - The highest theoretical possible cost.
  - The target cost.
  - The probability that the actual cost would be less than or equal to the target cost.

An attachment to DMA (1999) labeled "Project Data Sources" shows whether the cost estimates for each project were provided by Rogers & Associates or by LMITCO.

An additional Excel spreadsheet provided by Rogers & Associates ("Alternatives and Projects 5-28-99") indicated the type of cost described by each of the 75 projects: Treatment & Storage (TS), Transportation (TR), or Disposal (D). This information was used to determine the relative contribution of each type of cost to the total expected cost for each of the 16 alternatives/options.

Monte Carlo Simulation

This cost estimation tool (also referred to as "simulation by random sampling") is a quantitative simulation technique used in many different types of decision analysis models. The first step in Monte Carlo risk analysis is to define the capital resources by developing a model of the estimate. The second step is to identify the uncertainty in the estimate by specifying the possible values of the variables in the estimate with probability ranges (distributions). The third step is to analyze the estimate with simulation. The model is run (iterated) repeatedly to determine the range and probabilities of all possible outcomes of the model.

D.1 Crystal Ball® Model – Components and Features

Crystal Ball® is a Microsoft Excel Add-in tool that uses Monte Carlo simulation to help analyze the risks and uncertainties associated with spreadsheet models. Features include sensitivity analysis, correlation, and distribution fitting to historical data.

Inputs

For the 31 TtNUS projects, the inputs were modeled using the Crystal Ball® simulation program.

- For four of the projects, the target cost was zero, and the input was therefore zero, with no uncertainty parameters. The four projects relate to transportation of HLW to the proposed Yucca Mountain Repository. Transportation costs for those four projects were included in the disposal cost.

- For the remaining 27 projects, the input was modeled as a Triangular Distribution, using the low, high, and target cost estimates.

For each of the 368 cost components in the 44 LMITCO projects, the inputs were also modeled using the Crystal Ball® simulation program.

- For 1 of the 368 cost components (where the target equaled the high estimate), the input was modeled as a Triangular Distribution, using the low, high, and target cost estimates.

- For the remaining 367 cost components, the input was modeled as a Custom Distribution as follows:

  – Segment 1: Describes a range from the low estimate to the target, with a probability equal to the LMITCO-provided probability that the actual cost would be less than or equal to the target.

  – Segment 2: Describes a range from the target to the high estimate, with a probability equal to 1 minus the probability in Segment 1.

The following is a more detailed description of the modeling of the Custom Distributions.

In Crystal Ball® modelers can input values in a series of continuous ranges that do not fit any of the standard modeling conventions (Binomial, Normal Distribution, Poisson, etc.). This type of input is called a Custom Distribution. For each of the ranges, the following values are provided:

Value 1 – the lower-most boundary of the range (or the left side of the range)

Value 2 – the upper-most boundary of the range (or the right side of the range)

Prob – the probability that the actual value will fall within the range just described.

For example, for Element 1 (Conceptual Design, PM, Permit) on the LMITCO Simulation Report for Project P1A (dated 5-5-99), the following data were provided: Target = 12,372, Prob = 25, Lowest = 10,417, and Highest = 39,000. A Custom Distribution with two ranges was modeled, as follows:

Range 1

Value 1 = 10,417 (lower boundary of Range 1, or the lowest value for the Project Element)

Value 2 = 12,372 (upper boundary of Range 1, or the Target value for the Project Element)

Prob = 25 percent (the probability that the final value of the Project Element will be at or below the Target value)

Range 2

Value 1 = 12,372 (lower boundary of Range 2, or the Target value for the Project Element)

Value 2 = 39,000 (upper boundary of Range 2, or the highest value for the Project Element)

Prob = 75 percent (the derived probability that the final value of Project Element will be greater than the Target value)

Outputs

The Crystal Ball® simulation model was run using 2,000 trials, and the results of each trial were summed up to the project level. The Crystal Ball Report function provided the following for each of the 75 projects:

- Summary Statistics regarding the expected cost of the project (mean, median, max, min).
- Frequency Distribution information for all 2,000 trials (table and chart).
- Percentile data regarding the expected total cost for each project.

An attachment to DMA (1999) labeled "Project Statistics" shows summary statistics, frequency distribution charts, and percentile data for each of the 75 projects. For each project it also lists the cost components included in the project totals (cost components are called "Assumptions" in the attachment), describes the way each component was modeled in Crystal Ball®, and provides the mean value returned for each component after the 2,000 trials.

D.2 Compilation of Results

The results of the Crystal Ball® output for each project were summed to arrive at total expected values for each of the 16 alternative/options. Items that were consolidated include: mean expected value, maximum and minimum expected value, percentile data, and frequency counts. Table D-1 is an example of how expected costs for each project were consolidated.

Table D-1. Example of alternative total calculation (Continued Current Operations Alternative).

		Unescalated 1998 costs (in thousands)		
Project Name	Project Number	Expected cost	Low cost (10%)	High cost (95%)
Tetra Tech NUS estimates				
Shipping TRU from INTEC to WIPP	112E	1,811	1,512	2,171
Newly Generated Liquid Waste Management and Tank Farm Heel Waste (Remote-Handled Waste) Disposal at WIPP	112F	21,136	18,691	24,938
		22,947	20,204	27,110
LMITCO estimates				
Remote Analytical Laboratory	18MC	184,376	158,052	221,887
Calcine SBW including New Waste Calcining Facility Upgrades	1A	741,301	679,810	829,979
Newly Generated Liquid Waste and Tank Farm Heel Waste	1B	399,937	369,546	439,810
Bin Set 1 Calcine Transfer	1E	59,021	49,804	71,154
Long-Term Storage of Calcine in Bin Sets	4	21,119	17,475	27,014
		1,405,755	1,274,687	1,589,845
Total (in thousands)		$1,428,701	$1,294,891	$1,616,954

References

DMA (David Miller and Associates), 1999, *Probabilistic Cost Simulation Study of the Idaho High-Level Waste Environmental Impact Statement Waste Processing Alternatives*, U.S. Department of Energy Idaho Operations Office, Idaho Falls, Idaho, June 8.

APPENDIX E

ANNUAL FUNDING PROFILES

APPENDIX E - ANNUAL FUNDING PROFILES

Annual funding requirements for the alternatives were analyzed using three different ways of considering the time value of money: unescalated dollars, escalated dollars, and net present value or discounted dollars. The bases of all three approaches are the life cycle cost (LCC) estimates that were prepared for the projects. Start and finish dates were assigned to each project, and the timing of estimated costs was calculated year by year. This analysis was done to give a rough idea of the amount of funds that would typically be needed year by year to implement an alternative. Each LCC estimate was initially developed using unescalated 1998 dollars. Escalated costs were then prepared using escalation factors (DOE 1997) directed by the U.S. Department of Energy (DOE) in accordance with Office of Management and Budget (OMB) Circular A-94 (OMB 1992). Net present value (NPV) for the alternatives was calculated by discounting the escalated costs at 6.10 percent (DOE 1997). All costs were conservatively discounted assuming the end-of-year convention.

The escalation factor takes the expected inflation rate into consideration. The NPV or discount factor represents the expected earnings (as in interest earned). An example is buying a bond today to pay for a young child's college education. The interest increases the value of the investment to cover the costs. The current value of the investment is the discounted value.

Results of the annual funding profiles are presented in Figures E-1, E-2, and E-3. The scale is the same on all three figures to emphasize the effect of escalating and discounting costs.

Figure E-1 illustrates the annual funding requirements in unescalated 1998 dollars for four selected alternatives/options:

- No-Action Alternative
- Transuranic Separations Option - Grout in Tanks
- Separations Alternative – Planning Basis Option
- Non Separations Alternative - Direct Cement Waste Option

These four options represent the lowest cost option (No Action Alternative), the highest cost option (Direct Cement Waste Option), the lowest cost option that produces waste forms that could meet disposal facility waste acceptance criteria (Transuranic Separations Option), and the option that the State of Idaho considers to be the closest to meeting all of the Idaho Settlement Agreement and Consent Order milestones (Planning Basis Option). All of the options could not be shown on the figure without making

Figure E-1
Annual Funding Requirements for Selected Alternatives -- Unescalated Costs

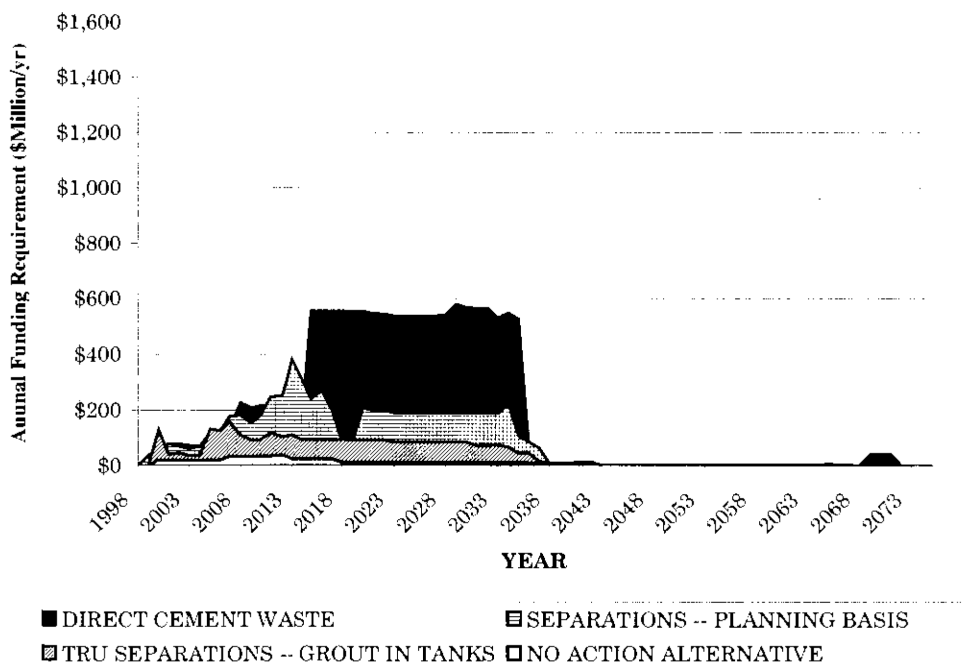


Figure E-2
Annual Funding Requirements for Selected Alternatives -- Escalated Costs

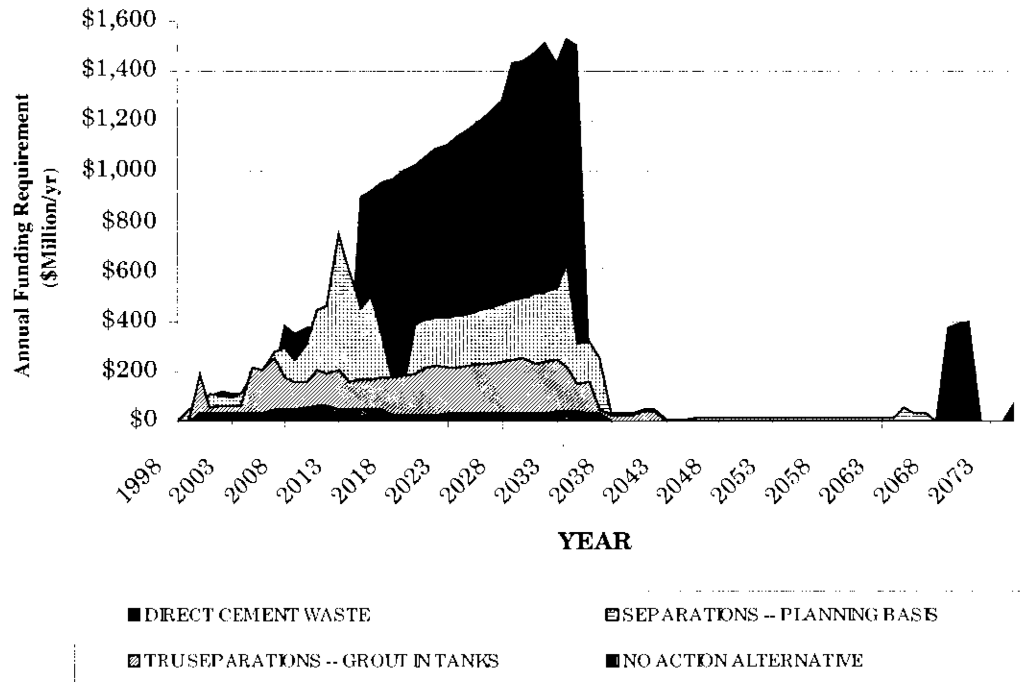
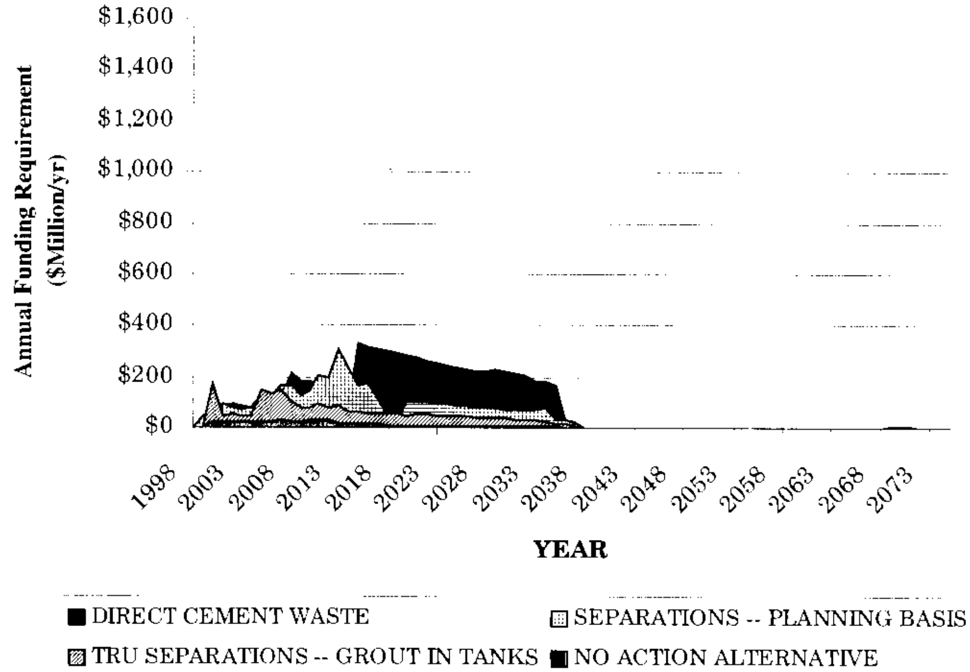


Figure E-3
Annual Funding Requirements for Selected Alternatives -- Discounted Costs



the chart unreadable. Of particular interest in Figure E-1 is the peak annual funding or spike for an alternative. The Transuranic Separations Option is the lowest cost of the options that would produce waste forms that might be accepted. However, a funding spike early in the process (about year 2001) of about $130 million may pose a difficulty because of the large variations in funding needs. The Planning Basis Option would have a much larger peak funding spike in year 2013 of about $380 million.

The cost increase in the years 2069 through 2073 is for closure of the Vitrified Product Interim Storage Facility at INEEL. The storage facility was assumed to stay open if the repository would not be able to accept the HLW.

Figure E-2 shows the escalated costs for the same four options that are presented in Figure E-1. The chart shows that projects with large out-year expenditures would experience higher costs due to the application of annual escalation factors.

The estimated costs of the same four options expressed in NPV are presented in Figure E-3. This figure demonstrates the effect of discounting the costs of future projects as though the money for the entire alternative could be put in the bank today and then used as the projects proceed through out the multi-decade project life. If a change of method in funding Federal projects were to occur that would allow the total project cost to be appropriated and placed in escrow, a substantial cost savings could be achieved for any of the alternatives.

In comparison with the fiscal year 1999 initial funding level of $50 million dollars for the HLW program, only the No Action Alternative could be implemented using the current level of funding.

References

DOE (U.S. Department of Energy), 1997, *Departmental Price Change Index, FY1999 Guidance, Anticipated Economic Escalation Rates, DOE Construction Projects and Operating Expenses*, January.

APPENDIX F

REPOSITORY EXPENSE BASIS

APPENDIX F – REPOSITORY EXPENSE BASIS

This appendix documents the basis of unit cost estimates for disposal of high-level waste (HLW) canisters in the proposed repository. The anticipated costs for disposal of HLW were estimated on the basis of a fee for disposal per canister of waste. The estimated fee is $540,000 per canister (Peel 1999).

Repository costs are funded in two ways: payments by nuclear utility companies to the Nuclear Waste Fund and planned payments by the U.S. Department of Energy (DOE) Environmental Management (EM) program to the DOE Office of Civilian Radioactive Waste Management (OCRWM) for the Defense Program HLW. OCRWM developed assumptions regarding:

- the inventory of DOE HLW that is planned for disposal at the repository
- the amount of the total repository costs that would be allocated to the DOE Defense Waste program
- the total cost for the repository and associated activities (DOE 1998)

The *Analysis of the Total System Life Cycle Cost of the Civilian Radioactive Waste Management Program* (TSLCC) (DOE 1998) assumes that 20,004 canisters of HLW will be emplaced in the repository from several HLW sites in the DOE complex including INEEL as noted in Table F-1. The TSLCC includes sunk costs (costs already incurred) and future estimated costs. The current estimated cost to EM that is assumed for disposal of DOE HLW and other wastes listed in Table F-1 is $10.8 billion.

Table F-1. Inventory of HLW assumed for the proposed repository (DOE 1998).

DOE facility	Waste type	Number of canisters
West Valley Demonstration Project, New York	Vitrified HLW	276
Defense Waste Processing Facility, Savannah River Site, South Carolina	Vitrified HLW	5,390
Tank Waste Remediation System, Hanford Reservation, Washington	Vitrified HLW	12,442
Idaho National Engineering and Environmental Laboratory, Idaho	Vitrified or otherwise treated HLW	1,190
Various sites	Plutonium "can-in-canister"	635
Argonne National Laboratory-West, Idaho	Sodium-bonded fuel	71
Total		20,004

The cost for TRU waste disposal at the Waste Isolation Pilot Plant is discussed in Sections 5.2.2 and 6.1.1 of this report. The basis of the TRU costs is the Waste Isolation Pilot Plant Disposal Phase Supplemental EIS (DOE 1997), pages 1-2 and 5-10.

References

DOE (U.S. Department of Energy), 1997, *Waste Isolation Pilot Plant Disposal Phase Final Supplemental Environmental Impact Statement*, DOE/EIS-0026-S-2.

DOE (U.S. Department of Energy), 1998, *Analysis of the Total System Life Cycle Cost of the Civilian Radioactive Waste Management Program.*

Peel, R. C., 1999, "Repository Cost Estimate Calculation," Rogers & Associates Engineering, April 15.